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JOHN F. DASHIELL
UNIVERSITY OF NORTH CAROLINA

Studies in the Psychology of the Deaf

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By

THE PSYCHOLOGICAL DIVISION
Clarence W. Barron Research Department
The Clarke School for the Deaf, Northampton, Massachusetts

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PREFACE

Psychological research was begun at The Clarke School for the Deaf September, 1928, by Dr. Margarete Eberhardt under the direction of Dr. Kurt Koffka, Professor of Psychology at Smith College. A special gift by Mr. Robert L. Studley of Boston made this endeavor possible. Since 1930 all research at The Clarke School receives its support from special allocated funds from the Coolidge Fund. At the end of the first year Dr. Eberhardt resigned to accept a position at the University of Hamburg, Germany. The results of Dr. Eberhardt's investigations are contained in the first paper of this monograph.

Fritz K. Heider, Ph.D., of the University of Graz, Austria, was appointed in 1930 to continue the research. The results of the investigations conducted by Dr. Heider and Mrs. Grace Moore Heider, comprise the remainder of this first report of the Psychological Division of The Clarence W. Barron Research Department of The Clarke School for the Deaf excepting the study, Vocalizations of Pre-School Deaf Children, which was contributed by Miss Jean L. Sykes. Miss Sykes conducted this study at The Clarke School under the direction of Dr. Heider and submitted her manuscript to Smith College in partial fulfillment for a Master of Arts degree.

More than passing recognition is due Dr. Kurt Koffka who served as Director of Psychological Research since its inception. He has given generously of his time and counsel. The Trustees and those intimately associated with research activities gratefully appreciate Dr. Koffka's sustained interest, his timely suggestions and scholarly advice which contributed vitally to the successful completion of the investigations incorporated in this monograph.

We also express our appreciation to the authorities of the Pennsylvania School for the Deaf, the North Carolina School for the Deaf, the Florida School for the Deaf, the public schools in Northampton, Florence and Amherst, and to the Principal of the Smith College Day-School and the Principal of the Smith College Nursery School for their co-operation and assistance in the acquisition of essential data.

The Trustees of The Clarke School for the Deaf.

FOREWORD

The most significant effect of deafness is the limitation that it imposes on language experience. The congenitally deaf child usually enters school without knowing a single word of the language that has been spoken in his presence from birth, or that he has a name, or that other people communicate with each other by speaking. During his school years the deaf child must acquire not only what the hearing child acquires through formal instruction, but also the whole language structure on which the education of the former must be built. If orally taught the deaf child must learn to speak words whose sounds he cannot hear and to understand other people by means of lip movements that do not fully correspond to the speech sounds which they help form. Further, his language experience, largely restricted to the single sense of vision, is much narrower than that of the normal person. As a rule, he apprehends only that to which he pays visual attention to the exclusion of other activities; whereas we can and must hear what is being said about us whether we will or not. This means that the deaf child does not experience the endless repetition of language forms by which the hearing child acquires new forms of expression and by which he gradually corrects the errors of his first formulations.

Further, the emotional and social atmosphere in which the deaf person lives, even from the first weeks of his life, is different from that in which the hearing person makes his adjustments to the world. The hearing infant is affected by the nuances of speech long before he can understand what is being said to him. All his life through the means of communication at his disposal, he can more readily enter into communication with the people about him than the deaf person. He lives in a world which is at once more secure and more flexible than that of the deaf person.

In view of these great differences in environment and consequent development the gap between the deaf and the hearing might be a very great one. Yet we find that the graduates of

schools for the deaf in different parts of the country are as a whole a responsible, self-supporting group. They go into trades, into high schools and colleges, and some few into the professions as their hearing brothers and sisters do; always to be sure with a definite handicap to be overcome, but usually making adequate adjustments to the world as they find it. That this is so gives proof that the educators of the deaf have to a large measure succeeded in their task of restoring children handicapped by deafness to their families and to the social world in which they must live. It shows the high order of courage with which pupils and teachers alike have worked to overcome the handicap of deafness.

Yet the problem is one that is far from being solved. The deaf are being taught to speak, but they could probable learn to speak still better if we knew how to do it; they can read the lips but there are still many who are far poorer in lip-reading than others; they adjust themselves to the social and economic situations that they meet after they leave school, but we may in time learn to give them still better preparation to meet the world. The history of the education of the deaf has been one of educational experiment. Miss Yale's story of the development of the education of the deaf in this country, especially at The Clarke School, makes one realize that the tremendous gains of the last century have come through the zeal and inspiration of leaders who made experiments. They were first of all great teachers and in the best sense of the word they were conservative in holding to what had been proved, but new ways were always being tried and each point was challenged by a real test.

From the point of view of the psychologist the privilege of working in a school for the deaf is a great one. The deaf child is, in a sense, a unique case; he is a human being with normal developmental possibilities who is deprived of ordinary language experience. He offers unusual opportunities for the study of the development of language, the influence of language on general development, and the growth of personality in different aspects.

Considering the possibilities of the field the work that has so far been done done with the deaf in this country is not extensive. The first systematic work was that of Pintner and Paterson with

testing. Pintner and his students carried this work further and recently contributions have come from others, from Helen Lane Schick at Central Institute and from Drever and Collins at Edinburgh. Among the most important recent studies are those of Pintner's students in the field of personality, especially of Brunschwig and Habbe. Experimental studies of lip-reading have been made by Russel and Mason at Ohio State University and of reading and language by Thompson working under Gates at Columbia. Research workers have reason to be grateful to Harris Taylor for his painstaking work in making a survey of research activities in the field. There are also analyses of educational method that have been made with real psychological insight and which are important for research work, for example, the work of Bruhn, Buell, Fitzgerald and Meyer.

The papers of this monograph deal with several different aspects of the psychology of the deaf. We hope that they will be of value in giving information about the mental development of deaf children and in this way contribute to the growth of educational method.

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I. A SUMMARY OF SOME PRELIMINARY INVESTIGATIONS OF THE DEAF

Made by

MARGARETE EBERHARDT

Dr. Margarete Eberhardt conducted a series of studies at The Clarke School before the Psychological Research Department as it now exists was established. The work was unexpectedly interrupted at the end of the first year when Dr. Eberhardt was called to another position, but the approach that was made was a fruitful one and the results are important for future work. A brief report of these studies follows.

I. Experiments on the intellectual development of young deaf children

These experiments were carried out with 21 children, five to seven years of age, some of whom had been in school for only two weeks, some for five months, and some for a year.

a. Grouping experiments: The child was seated at a table covered with a variety of objects and, by demonstration, given the task of selecting groups of objects on the basis of similarity. For the demonstration only objects that were visually identical or very similar were put together. The children made groupings like those of the demonstration on the basis of sensory similarity, but went beyond these and made groupings of objects that were similar in function although entirely different in appearance (for example, different kinds of food, objects to cut with, etc.); and of objects that were parts of a single whole (for example of a static whole such as a purse and some money, or an ink bottle and its stopper; or of a functional whole such as an apple and fruit knife).

All of these kinds of groupings occurred with each child, although those that were based on functional similarity alone were less frequent with younger than with older children. Differ-

ences within the group in length of school training were unimportant.

The ability of the children to group objects that were visually alike indicated that the visual field of the young deaf child is clearly articulated and that he can make differentiations within it, but they told nothing more of his mental development. More significant are the cases of groupings in terms of functional relationships alone. These show that the child is thoroughly familiar with the use of the objects involved and that without the help of language or any special training he has come to feel that the functional aspect of an object is as characteristic as its size, shape, or color.

b. Experiments with space concepts: The same group of children was taught the meaning of words of position (on, under, behind, in front of, between, through) in relation to a box standing on the table. The words were presented in written form. After having learned them thoroughly in relation to the box, all of the children were able to apply them without further help to other objects in different situations. Differences of age or development had no influence on the child's ability to apply the terms to new situations, although they affected the original learning process. The ease with which the children used the terms in varied situations showed again the high degree of organization of the visual field of the young deaf child.

c. Experiments on "and" and "or": A third series of experiments was made to find out how far concepts such as "and" and "or" are developed in the deaf child before he has acquired language and, in cases where they are lacking, how much difficulty is involved in establishing them. The method used was the following: The subject was seated at a table on which were spread out little squares of colored paper. A card was shown with a single colored square and the child told to select a paper like it from the table. This all of the children could do easily. The child was then shown a card with two squares of different colors connected by the word "and." The children were able to give two papers of the proper colors. As a next step they were

shown a card with two squares united by the word "or" and taught to give either one of the corresponding papers.

At this stage the concepts were probably not "and" and "or," but "all" and "one of them." Further variations of the method were used until the concepts "and" and "or" were clearly established. A comparison of the time required to learn "or" and that required to learn the space terms of the preceding experiment or to learn "and," leaves no doubt that the concept "or" was an entirely new one for the deaf children. Yet more than 80% of them were able to get a fairly clear idea of what "or" meant by the end of the third working period of a quarter of an hour.

II. Experiments on the thinking of the deaf

The method of introspection was used with fifteen of the older boys and girls to determine what characteristic differences may exist between deaf and hearing children in their thinking.

a. Experiments on immediate memory: Sentences or series of numbers were presented orally or in written form. The children were asked to write down what they remembered and to tell how they had recalled it. The data so obtained made it possible to distinguish between children who depended largely on visual imagery, either of the written form or of lip-movements of the oral presentation, and those who described the memory largely in terms of sensations of the speech organs. An example of this second type is the report, "I remember how it feels if I say the words myself." A third group relied on both kinds of data, and for some who had residual hearing acoustic images also played a part. In general the results indicated that for the deaf the loss of acoustic memory images of language is compensated for by visual images of movements of the lips or by somaesthetic images of the word patterns in the speech organs. There was no evidence that other memory images, for instance of taste or smell, were more strongly developed in deaf than in hearing persons.

b. Thought experiments: A series of simple tasks was given to each child, for example: adding simple sums, sentence completions, making up a story using a few words that are given,

recounting a story that was read. The subjects were instructed to pay attention to what was going on in their consciousness while they performed the tasks and to describe their observations as soon as the original task was finished. The descriptions were like those of the preceding experiment except that visual images of lip movements rarely occurred. These seem to be important only for the recall of what has just been seen on the lips of another person. The distinction between visual and somaesthetic responses was again clear. For instance, some children reacted to the word "kindness" with a response like: "I see people giving presents to others and receiving others kindly," while others whose responses were of the more somaesthetic type responded: "Kindness brings happiness and unselfishness; I feel those words in my mouth." Some of the visual images described were so vivid as to suggest that eidetic imagery may have been involved.

Answers to questions also suggested that in many cases "thinking in meanings" is of greater significance for the deaf than "thinking in words," at least as long as they do not talk with the same ease as the hearing. For instance, 12 children who were asked about their reading said that they preferred to read stories silently because then they can get the meaning of whole paragraphs without thinking of the meaning of each single word. One former pupil, to whom psychological terms were familiar said, "I feel word patterns in my mouth only when I read very slowly; when I am reading more rapidly I only get the meaning of what I am reading."

III. General remarks on emotional and intellectual attitudes of older deaf children

A preliminary study of answers by deaf children to a series of general questions about their own attitudes and problems was made.[1]

Probably the most significant of this material is that dealing with the development of concepts in young deaf children without language. The experiments show that the world of the young

[1] This work will be referred to in a later study on the psychological situation of the deaf.

deaf child is already organized beyond the perceptual level and that this organization closely follows that of speaking people. They show clearly that language is not essential for organized conceptual thought, at least during its first stages. They are interesting, from an educational point of view, in showing that much of the first language development of the young deaf child in school consists in the learning of words for ideas that he already knows and uses in his everyday life, not as one might believe *a priori,* in the development of conceptual thinking by means of language symbols in a child whose world up to that point has been a more or less unorganized one.[1] Of course there are many instances in which a new word introduces a new conceptual relationship, but this is also true for hearing persons.

[1] This has been confirmed by other experiments. *Cf.* the report of color sorting experiments made with deaf children.

II. A COMPARISON OF COLOR SORTING BEHAVIOR OF DEAF AND HEARING CHILDREN

The following experiments were suggested by an investigation made by Gelb and Goldstein (2) of aphasics. They worked with patients whose language disturbance involved the use of color names. The patients were often quite unable to name colors or to use color names if they were supplied by the experimenter. Sometimes they succeeded in using descriptive words instead, thus *cherry-colored* for *red,* or such phrases as *like an orange, like a violet.* Conversely a patient who was given a color name and asked to select the corresponding hue succeeded only by a descriptive detour. One who was asked to find red said to himself, " Red. Blood is red." and performed the task by selecting a hue the color of blood (3, p. 488).

Gelb and Goldstein made experiments with these patients to see whether their *behavior* in regard to colors was also affected. These experiments showed significant differences in color sorting between their behavior and that of normal persons. The patients made no mistakes in tasks that involved simple color matching. When they were given pieces of colored material and told to select others exactly like them they distinguished accurately between shades that were but slightly different from each other, as a normal person would. But when they were asked to select a series of related hues there were at once gross differences. A subject who was given a piece of red worsted would select another of exactly the same shade, but would reject one which was slightly more yellow or more blue. His responses indicated that he found it as different from the standard as another primary color. Apparently the color was seen as an individual hue and not as a representative of a class. For normal subjects the task of selecting colors similar to a given standard organizes a pile of colors from which the choice is to be made into color series but for these patients it remains a motley of separate hues.

Similarly the color name as used by the normal person is the name not of an individual hue but of a color class.

The same kind of limitation to single concrete objects showed itself in other ways with the aphasic, in regard to number for instance. In each case Gelb and Goldstein believed that the peculiarities of behavior and the language disturbances went together, and that both were indications of changes in thought processes resulting from the brain lesion. They expressed these differences by saying that the behavior of the normal person may be categorial while that of the aphasic is limited to single, concrete cases. Further, they interpret this restriction as a shift to a lower, more primitive level of thought, although they are careful to explain that the more primitive forms of behavior that appear in a patient never have exactly the same form as those of a normal person at an earlier ontogenetic or phylogenetic stage (3, p. 437).

The deaf child [1] is superficially like the aphasic in that he is also restricted in his use of language. When he enters school he usually has no language beyond a few crude gestures and it is very gradually if ever that this initial handicap is fully overcome. Tests have shown a significant retardation in his use of language even after years of school training (5). The cause of the handicap is entirely different in the two cases, being the result of lack of language experience in the one, of a disturbance of brain function in the other. But it is interesting, nevertheless, to find out whether the language retardation of the deaf child is accompanied by behavior at all similar to that of the aphasic. Closely related to this question is the second, of what the alteration in the color behavior of the aphasic means in terms of normal development. Will the difference between his behavior and that of normal persons be at all similar to differences between less and more mature persons?

[1] By deaf child we mean one who is deaf from birth or early childhood and consequently could not have learned to speak without special instruction. The subjects of the experiments which we report were all chosen so as to fall within the limits set by this definition. That is, none were included who had lost their hearing after they had learned language or who retained sufficient hearing to have acquired speech through that channel.

To answer these questions we made a series of color sorting experiments with deaf and hearing children of different ages. If the deaf child's language retardation indicates a similarity in thought and behavior to that of the aphasic we would expect the deaf to show a tendency to simple color matching in an experimental situation to which normal hearing persons would respond by selecting a series of related hues. Further, if the behavior of less mature normal persons is closer to that of the aphasic than the behavior of more mature ones we will expect to find color matching more frequently with younger children, both deaf and normal than with older and more mature ones.

In addition to a preliminary experiment which was made only with a group of deaf children there were four different experiments made with comparable groups of deaf and hearing subjects. The preliminary experiment and the three following it were alike in principle but made with different and, in successive experiments, more carefully graded color series. Following is an outline of these experiments.

Preliminary Experiment. The material consisted of 81 one-inch cubes enamelled in 27 different hues to give a continuous chromatic series of medium brightness with darker and brighter shades of some of the hues of the continuous series, also some neutrals and browns. The procedure, which was the same for the experiments that followed, was to spread the colors out on the table in front of the child in irregular order, hold one up, and ask the child to select the others that were similar. The experimenter first performed the task herself, using the blue of medium brightness as a standard before letting the child begin. Records were kept of the cubes selected, of the order of selection, of any color names spoken by the child as he worked, and of the time required to make the selection for each standard. The following hues were used as standards, in order: yellow, violet-blue, yellow-green, red-violet, blue, green-yellow, and red. Forty deaf children (ages 6–11) served as subjects.

Experiment I. The standard Milton Bradley series of colored papers mounted on one-inch tablets of cardboard was used. The

series is made up of 18 variants including the six hues, red, orange, yellow, green, blue, and violet and two intermediates between each. Blue, orange, violet, green-yellow, red, green, and yellow in order were used as standards. Thirty-two deaf children (ages 5 : 3–17 : 4) and thirty-five hearing children [1] (ages 5 : 2–13 : 10) acted as subjects. The youngest deaf children (Group 1) understood the names of the primary colors but did not know how to speak them. Those of Group 2 understood all the common color names and were able to speak most of them. The others could speak all the names for the standard colors.

The deaf children of Groups 1 and 2 had taken part in the preliminary experiment which was given two months earlier than Experiment I.

In making the experiment with hearing children we varied the procedure to the extent of speaking more as we showed what was to be done: Thus, " Now, watch. I am picking out all the colors that go with this one. Now you do it," etc. The two groups of children seemed to understand equally what was wanted and to make their selections in much the same way. It seemed unwise to use exactly the same procedure with the two groups. Not all the deaf children could understand the language that seemed natural to use with the hearing children, and to have explained the experiment without speaking to the hearing children would have made the situation an artificial one for them.

Records were made of the number of hues selected for each standard and of the order of selection. The time records of the preliminary experiment had proved of no value and were discontinued.

Experiment II. The materials for this experiment were twelve of the hues used in Experiment I, the four primaries, red, yellow, green, and blue with two intermediates between each. The series was reduced in this way since that of Experiment I, by treating orange and violet as primaries, gave unequal numbers of intermediates between the different steps in the spectral series and made it impossible to compare selections made according to

[1] The hearing children were pupils in the Smith College Day School.

different standards. There were two tablets of each hue because it seemed likely that if we used only twelve the children would notice how many they took each time. Each color of this reduced series was used as a standard and also orange and violet which were no longer included in the series for selection.

The experiment was made with fourteen deaf children (ages 6:6–12:6) and fourteen hearing children (ages 6:6–12:8). They were divided into age groups such that there was a difference of one and one-half years between the oldest children of the first and the youngest of the second age groups. The deaf children of Group 1 understood the names of the primary colors but were not able to use all of them. Those of Group 2 could speak all the common color names. All of the children had taken part in Experiment I two months earlier.

Experiment III. For this investigation we used a closely graded series of twenty-five hues, ranging from blue to yellow through red. The series was made by painting one-inch squares of cardboard with water colors. The procedure was first demonstrated with the Milton Bradley colors of Experiment I using green as the standard for selection. After the demonstration the experimenter showed the child the new color series, held up a duplicate of the central red, and asked him to select the others that belonged with it.

The experiment was made with seventy subjects, forty deaf (ages 4:1–18:3), and thirty hearing (ages 4:5–12:8) and a group of adult hearing subjects, members of the teacher training class at Clarke School taken for comparison with the eldest group of deaf subjects. The experiment was later repeated with six children from the Smith College Nursery School, ages 1:9, 2:2, 2:3, 2:5, 2:6, and 3:3.

Experiment IV. The material of Experiment III was used and the procedure was the same except that instead of showing the standard the experimenter used the color word. The subject was told to find the "pink" ones. The word "pink" was used instead of red since the colors were not saturated and the children had spontaneously spoken of the standard in that way. All the

subjects of Experiment III took part in this experiment except the youngest group of deaf children who did not know the color names. Half of the subjects began with Experiment III and

TABLE I

RESULTS OF EXPERIMENTS I, II, III, AND IV: AVERAGE NUMBERS OF HUES SELECTED BY DEAF AND HEARING SUBJECTS OF DIFFERENT AGE GROUPS

Experiment I

Group	1	2	3	4	5
Ave. Age	5:9	7:7	10:5	12:7	15:6
			Number in Group		
Deaf	5	10	8	—	9
Hearing	8	9	10	8	—
			Ave. Number of Hues Selected		
Deaf	6.31	4.20	3.97	—	2.57
Hearing	5.4	4.44	3.2	3.5	—

Experiment II

Group	1	2
Ave. Age	7:0	10:10
	Number in Group	
Deaf	6	8
Hearing	6	8
	Ave. Number of Hues Selected	
Deaf	2.99	2.24
Hearing	2.51	1.82

Experiments III and IV

Group	1	2	3	4
Ave. Age	6:5	8:7	11:8	Adult
		Number in Group		
Deaf	10	10	10	10
Hearing	10	—	10	10
		Ave. Number of Hues Selected (Exp. III)		
Deaf	8.2	7.1	6.6	6.0
Hearing	6.7	—	5.6	5.4
		Ave. Number of Hues Selected (Exp. IV)		
Deaf	—	6.4	5.9	5.1
Hearing	6.6	—	4.9	4.7

half with Experiment IV. There was an interval of over two weeks between the two experiments.

With the deaf children the color name was written in order to avoid the possibility of error through lip-reading.

Results. Table I and Figure 1 summarize the results of Experi-

ments I, II, III, and IV giving for each group the average of all the choices made in each experiment. In Experiments I and II a series of standards was used and the average represents the results of all the different selections that were made. In Experiments III and IV the average represents the results of selections made according to one standard. Figure 1 gives curves based on the data presented in the table. It is not possible of course to com-

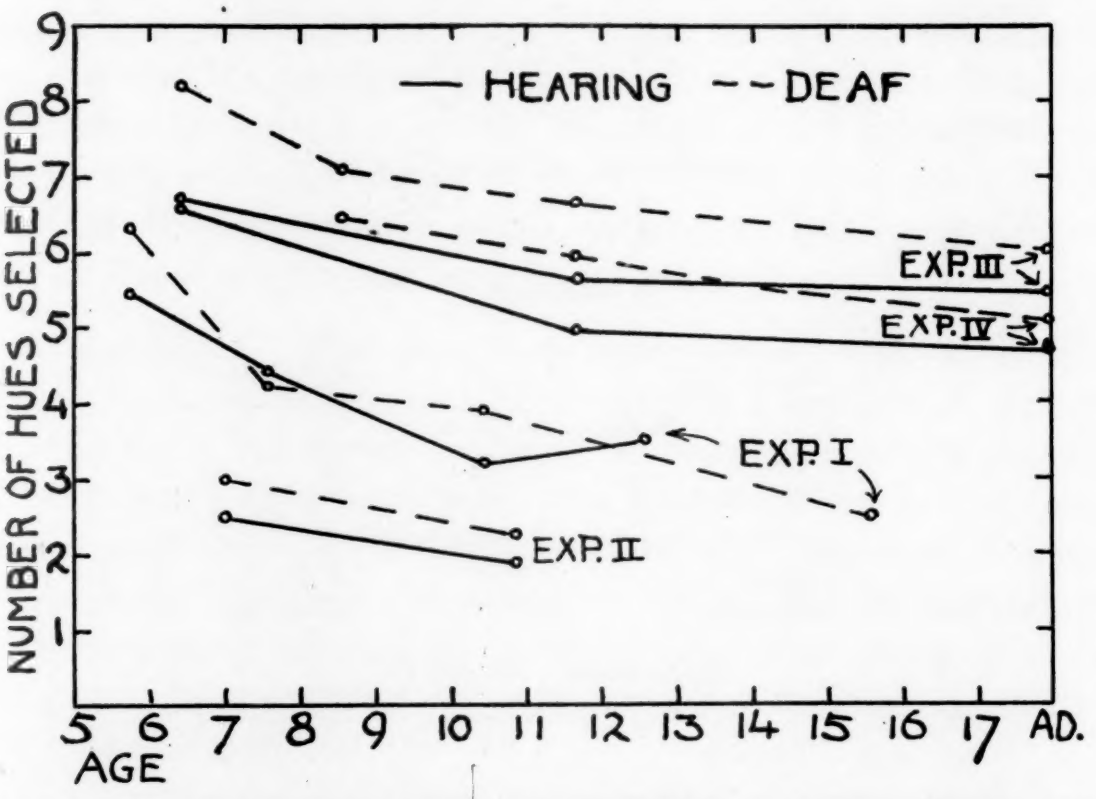

FIG. 1. Results of Experiments I, II, III, and IV: Average Numbers of Hues Selected by Deaf and Hearing Children of Different Age Groups.

pare the absolute results obtained from the first two experiments with those of other experiments since the number of choices possible varied with the material of the experiment, but the relation of older to younger, of hearing to deaf subjects is clear. We see that with only one exception (Experiment I, Group 4, Hearing) the average range for groups of younger children was wider than that for older ones and further that deaf children, instead of tending to match colors of a single hue made selections that included a still wider range of related hues than did normal

subjects. Of the thirteen comparisons of averages for selections made by corresponding age groups of deaf and hearing subjects there is only one exception, a case in which the selection made by the hearing was very slightly greater than that made by the deaf in Experiment I, Group 2. Group 4 of that experiment would doubtless have made a second exception if the comparison with the deaf had been made at that age level. These averages make it clear that differences between the performance of deaf

TABLE II

RESULTS OF EXPERIMENT I: AVERAGE NUMBER OF HUES SELECTED FOR EACH STANDARD BY DEAF AND HEARING CHILDREN OF DIFFERENT AGE GROUPS

	Deaf					Hearing				
Group	1	2	3	4	5	1	2	3	4	5
Ave. Age	5:10	7:6	10:9	—	15:6	5:8½	7:8½	10:2½	12:7	—
Number in Group	5	10	8	—	9	8	9	10	8	—
	Ave. Number of Hues Chosen for Each Standard									
Red	6.2	4.1	3.4		2.9	5.5	4.0	2.6	3.1	
Orange	6.4	4.8	5.1		2.7	6.4	5.1	4.1	4.2	
Yellow	7.0	3.6	2.9		2.8	4.1	5.1	2.1	2.9	
G.-Yel.	7.2	3.4	3.5		2.9	5.5	4.3	2.9	3.6	
Green	4.8	3.3	3.4		2.0	3.5	3.4	2.4	2.9	
Blue	6.8	5.0	5.3		2.4	6.4	4.7	4.5	4.2	
Violet	5.8	5.2	4.2		2.3	6.4	4.5	3.7	3.5	
Ave.	6.31	4.20	3.97		2.57	5.4	4.44	3.2	3.5	

and hearing subjects in no way resembled differences that Gelb and Goldstein had found between aphasics and normal subjects.

Table II and Figure 2 give detailed results for Experiment I, showing the average range of selections made by deaf and hearing children of four different age groups for each of the seven standards separately. Table III presents the differences between older and younger, between deaf and hearing children in terms of the selections made for the single standards. Only the first three age groups are included in this comparison. Group IV was made up only of hearing children and Group V only of the deaf so they could not be used in a direct comparison although they are significant for the averages of Table I. For the comparison

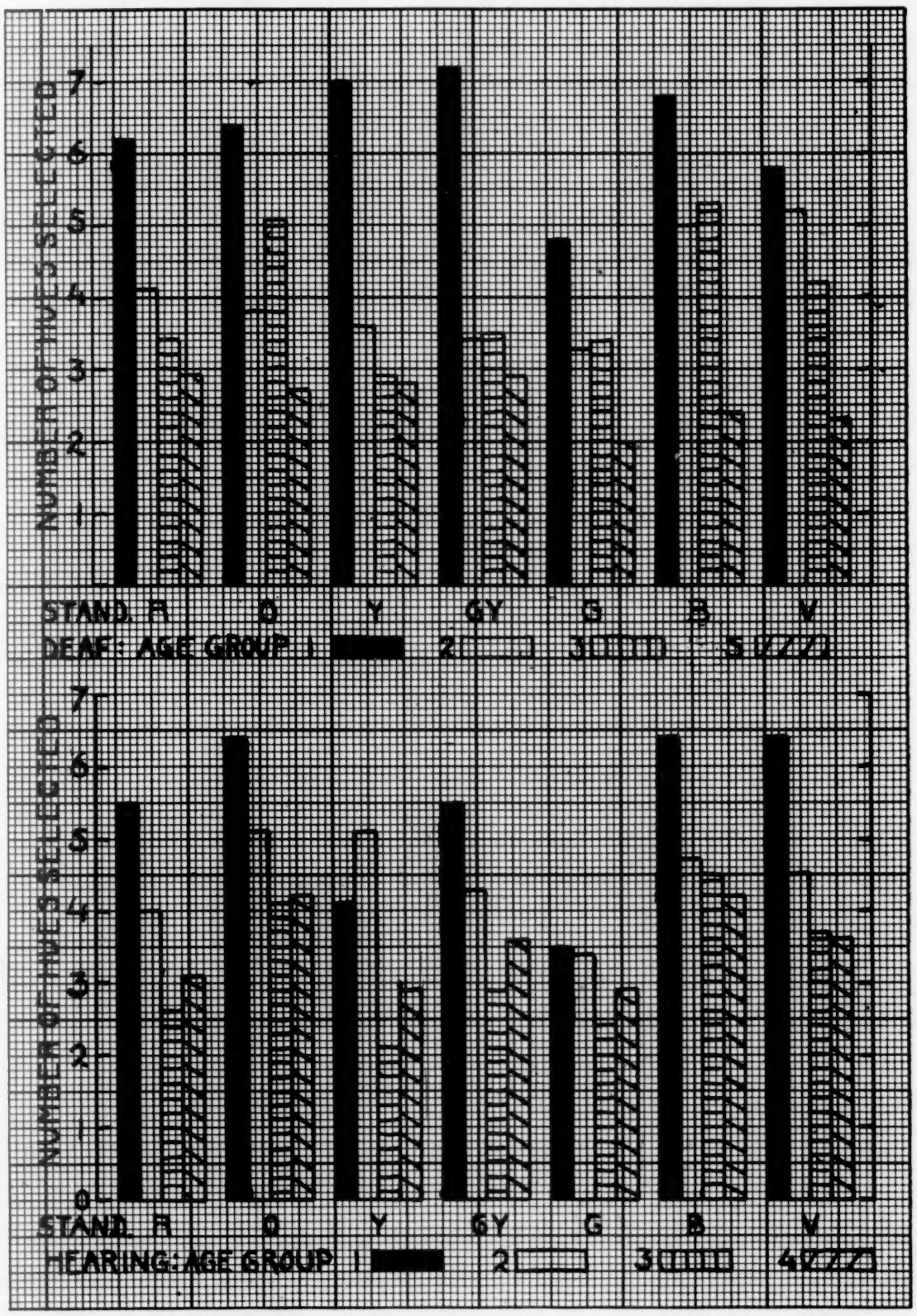

FIG. 2. Results of Experiment I: Average Number of Hues Selected for Each Standard by Deaf and Hearing Children of Different Age Groups.

shown in Table III the results for Groups I and II for each standard are averaged and compared with those for Group III.

Table IV gives the data of Experiment II in terms of the single color standards. The seven standards of Experiment I and the

TABLE III

RESULTS OF EXPERIMENT I: DIFFERENCES IN AVERAGE NUMBER OF HUES SELECTED FOR EACH STANDARD BETWEEN OLDER AND YOUNGER CHILDREN; BETWEEN DEAF AND HEARING

	Deaf			Hearing			Difference: Deaf-Hearing	
			Difference			Difference		
Groups	1 & 2	3	(1 & 2)–3	1 & 2	3	(1 & 2)–3	1 & 2	3
Ave. Age	6:8	10:9		6:8	10:2			
Number in Group	15	8		17	10			
	Ave. Number of Hues Chosen for Each Standard							
Red	5.1	3.4	+1.7	4.7	2.6	+2.1	+0.4	+0.8
Orange	5.6	5.1	+0.5	5.7	4.1	+1.6	—0.1	+1.0
Yellow	5.3	2.9	+1.4	4.6	2.1	+2.5	+0.7	+0.8
Gr.-Yel.	5.3	3.5	+1.8	4.9	2.9	+2.0	+0.4	+0.6
Green	4.0	3.4	+0.6	3.4	2.4	+1.0	+0.6	+1.0
Blue	5.9	5.3	+0.6	5.0	4.5	+0.5	+0.9	+0.8
Violet	5.5	4.2	+1.3	5.4	3.7	+1.7	+0.1	+0.5
	5.2	3.97	+1.23	4.9	3.2	+1.7	+0.3	+0.53

TABLE IV

RESULTS OF EXPERIMENT II: AVERAGE NUMBER OF HUES SELECTED FOR EACH STANDARD BY DEAF AND HEARING CHILDREN OF DIFFERENT AGES

Differences between older and younger; between deaf and hearing

	Deaf			Hearing			Difference: Deaf-Hearing	
			Difference: 1–2			Difference: 1–2		
Group	1	2		1	2		1	2
Ave. Age	7:0	16:9		7:0	10:11			
Number in Group	6	8		6	8			
	Ave. Number of Hues Chosen for Each Standard							
Red	1.83	1.75	+ .08	1.5	1.5	0.0	+0.33	+0.25
R.-Or.	2.00	2.00	0.0	1.6	1.5	+0.1	+0.4	+0.5
Orange	2.3	1.9	+0.4	2.7	1.6	+1.1	—0.4	+0.3
Y.-Or.	2.3	1.3	+1.0	2.0	1.6	+0.4	+0.3	—0.3
Yellow	3.7	2.2	+1.5	2.5	1.6	+0.9	+1.2	+0.6
G.-Yel.	3.7	1.9	+1.8	2.7	2.1	+0.6	+1.0	+0.2
Y.-Gr.	3.3	2.0	+1.3	2.7	2.2	+0.5	+0.6	—0.2
Green	4.7	2.9	+1.8	2.7	2.2	+0.5	+2.0	+0.7
B.-Gr.	3.8	2.4	+1.4	3.5	2.1	+1.4	+0.3	+0.3
G.-Blue	3.3	3.5	—0.2	3.2	1.7	+1.5	+0.1	+1.8
Blue	3.3	3.1	+0.2	3.2	2.3	+0.9	+0.1	+0.8
B.-Vi.	3.0	3.1	—0.1	2.8	2.1	+0.7	+0.2	+1.0
Violet	2.0	1.6	+0.4	2.5	1.4	+0.1	—0.5	+0.2
R.-Vi.	2.5	1.7	+0.8	1.8	1.5	+0.3	+0.7	—0.2
Ave.	3.0	2.2	+0.8	2.5	1.8	+0.7	+0.5	+0.4

fourteen of Experiment II are thus shown, each in two age comparisons, i.e. once for deaf and once for hearing children. In the same way the comparison of deaf and hearing is made with both younger and older children for each standard of the two experiments. This means that the data on which the general averages of Table I are based are shown as the results of forty-two part experiments, both for the comparison of older and younger children and for that of deaf and hearing children.

These single comparisons show the consistency of the data on which the averages of Table I are based. There are a few cases in Experiment I in which the differences between the single age groups do not follow the direction indicated by the general averages but there are none in which the average of the ranges of the two younger groups is not greater than the range for the third group. In Experiment II the number of hues selected was smaller for older than for younger children in twenty-four of the twenty-eight experiments. In two cases it was equal and in two it was slightly larger for older children.

In the comparison between hearing and deaf children of equal ages there was only one case of the fourteen in Experiment I in which the average number of hues selected by the hearing was not greater than that selected by the deaf and four cases out of the twenty-eight of Experiment II. Throughout the whole series of experiments there were no cases of matching except in Experment II in which the steps between shades were so great as to make such choices more likely than in other experiments. And since this occurred more often with hearing than with deaf, more often with older than with younger subjects, it did not seem related to similar behavior on the part of the patients of Gelb and Goldstein.

The differences between the selections according to different color standards have no meaning as far as this experiment is concerned, but the consistency of the direction of difference in the large number of single comparisons between deaf and hearing, between younger and older children in the long series of selections involved in the two first experiments is statistically important in showing the validity of the results. Because of the agreement

between these separate comparisons we did not determine the mathematical reliability of the data. The groups were too small for us to do it satisfactorily for the four experiments separately and nothing would be gained, in view of this general agreement of the results, by grouping them for a single measure of reliability. This means that the color matching behavior of the aphasic, although it may be spoken of as more primitive in the sense in which Gelb and Goldstein use the word does not represent behavior which is genetically prior in normal development. In order to be sure of this conclusion we repeated Experiment III with still younger children, the nursery school group. It seemed possible that our curves might apply to children in whom verbal or, in the case of the younger deaf children, symbolic behavior of some other form was already established and that we could go back to a pre-verbal stage in which categorial behavior, as Gelb and Goldstein described it in regard to color sorting, might also be lacking. But from this point of view the results of the experiment were entirely negative. The youngest child was unable to understand the task at all. The next four children, in order of age, began the task as the older subjects had done, first selecting hues that were close to the standard, but continued their selections until practically the whole series was included. Only the oldest child of this group made a definite stop before the end of the series, and that after selecting eleven hues centering about the standard.

These results indicate that the normal ontogenetic development is not from color matching to the selection of a series of related hues, a result which the studies of aphasics had suggested as one possibility. As soon as the children understood the experiment sufficiently to carry it through with any degree of consistency they selected hues over a wide range.

We find then that deaf children make selections which resemble those of less mature hearing children rather than those of aphasics. Instead of tending to match single colors they made choices that involved a still wider range of related hues than those of hearing children of the same age. The difference between deaf and hearing, younger and older children probably

represents a differentiation of behavior that is characteristic of development, from whatever aspect it is considered.

Experiment IV was made to find out how the color sorting behavior of the two groups would change if it was carried out with reference to a verbal symbol rather than to an objective standard. The results show the same differences between older and younger and between deaf and hearing children that appeared in the first experiments. Further, the range of selection is narrower for this experiment in which the color name was used. Insofar as we are correct in saying that a narrow range represents a higher, more mature performance we can say that behavior directed by the word is of a higher order than that in which the objective standard was used. There was, of course, no absolute distinction between the two experiments since many of the children, both deaf and hearing, spoke the color name as they were shown the standard and may have been doing the same task in the two cases. But that a consistent difference showed in the results in spite of this fact makes it clear that there was a real difference between the two experiments in many of the cases.

While this direction of difference between selections of deaf and hearing children is important it is probably less significant in the end than the fact that the difference itself was not a great one. This indicates, that as far as this task is concerned, the behavior of the deaf child is not radically different from that of normal persons. This conclusion is in agreement with Eberhardt (1) who believed that young deaf children show considerable use of general concepts. This is also supported by negative evidence from other comparisons to which we subjected the data of the experiments. We studied the results of Experiment II to measure the relative rigidity of the color series, i.e. the degree to which the selections varied according to the standard. The standards were considered according to their order in the color series and the selection for red-orange was compared with that for red, the selection for orange with that for red-orange, etc. Those cases in which the same selection was made for two successive standards were called " identical ", the others " different." The " different " selections were then distinguished as positive

if the difference was that indicated by the change of standard, negative if it was in the opposite direction. Thus, if for red a subject selected red, and red-orange, and for red-orange he selected, red, red-orange, and orange the change was positive. But if for red-orange he then selected only red it was negative. Identical selections of this sort were followed by breaks in the series of selections; i.e. the child who made the same selections for red, for red-orange, and for orange would be forced to make an entirely new selection for yellow-orange or for yellow. Thus one may say that the greater the number of identical selections the more rigid the color series; i.e. the more frequently we will find fixed groups which are treated as closely related and the more definite will be the gaps between them.

We tried to find out whether groupings of this sort occurred more often with hearing than with deaf children or vice versa. If one takes the kind of selection made by the hearing as normal, any marked deviation on the part of the deaf child would probably indicate differences in the influence which language exerts on the behavior of the individual. The direction of this difference should tell something about the nature of this influence. There were however, no consistent differences between our groups, either when we considered the ratio of identical selections or of positively different selections.

We made further comparisons to see whether one group tended more than the other to make selections which were symmetrical in relation to the standard, for instance if for *green* as many hues on the yellow as on the blue side of the standard were selected. We also tried to see whether the primary hues played a more important part in the selections for one class of subjects than for the others. Thus, with the green-yellow standard which lay between the primary yellow and the yellow-green in the color series, we compared the number of unsymmetrical selections in which only the hues like the standard and the adjacent primary were selected with those in which the adjacent intermediate yellow-green was taken instead. Neither of these comparisons showed consistent differences between older and younger, or between hearing and deaf children.

These experiments alsc have bearing on color experiments made by Peters (4) with children of retarded mental development. He observed selections made for a given standard from a pile of worsteds by children who knew no color names, children who know some of the color names but did not apply them correctly, and by the same children after they had learned the correct names for both primary and intermediate colors. He found that children having no color names associated with single colors, and those who used the names for both primary and intermediate colors correctly made no mistakes in sorting the colors; i.e. they never grouped primaries and intermediate hues. Children who used the same name for a primary and an intermediate hue, grouped the two. His conclusions were that language organization when it was present at all tended to dominate perceptual organization. " In Wirklichkeit erfolgt die Lösung unter der dominierenden Mitwirkung des Wissens um die Farbennamen."

We had, among the deaf children, subjects corresponding insofar as their use of color names was concerned to those of Peters, the youngest knowing no color names, the oldest using all the color names correctly, and a middle group that knew only the names of the primaries and often used the same names for intermediates. However we found no evidence of distorted perceptual organization in those of the middle group. That the selections were not determined by the color names is shown by the following examples: One of the deaf children called the green-yellow " green " selected only yellow to go with it. She rejected yellow-green. Another who was given a blue-red called it " purple " but selected one which she called " pink " to go with it, rejecting the red-blue which she called by the same name as the standard. Her verbal and her perceptual systems were different but each was firmly established and there was no apparent interference between them. This is very significant since the deaf child must necessarily learn language more slowly than the normal child and must go through a long period during which verbal concepts have been established but are quite inadequate to the world in which he lives. If there were such dominance of verbal organization with deaf children as Peters found with children of subnormal

mental development, these years would be a period of perceptual confusions. The difference between the two cases probably lies in the fact that the original perceptual system of the deaf child is stable and well-articulated. That of retarded children, on the other hand, may be so labile as to shift under any influence such as that exerted by language.

This does not mean that color names were entirely irrelevant as far as the selections were concerned, only that they did not dominate them as Peters found with his subjects. There was always a definite and comprehensible relationship between the name when it was used and the colors which were being handled. This relationship was especially interesting in the case of the intermediates which had no proper names of their own, for example green-yellow. In Experiments I and II where there were two intermediates between yellow and green the hue adjacent to yellow was sometimes called yellow and sometimes green. But the selections made in the two cases indicated that the names were not equivalent. When it was called "yellow" the greener hues (yellow-green and green) were rarely selected to go with it, only the standard and the primary yellow. Apparently it was then *a yellow*. But when it was called "green" yellow as well as greener hues were selected. In this case the word green seemed to be used as an adjective in the sense "a greenish color" or possibly a "greenish yellow" and both the yellow and the greener hues went with it.

Summary and Conclusions: Gelb and Goldstein reported cases of aphasics who were unable to select a series of related hues although they could match single hues. They describe this limitation as one aspect of a lower, more primitive kind of behavior which also manifests itself in the language disorder of the patient. The experiments described in this paper were made to find out whether the language handicap of the deaf also involves the peculiarities of behavior observed in the aphasics. A comparison of deaf and hearing children in color matching experiments showed:

1. Deaf children select colors over wider range than hearing children of the same ages.

2. Younger children, both deaf and hearing, select colors over a wider range than older ones.
3. The kind of color matching behavior described by Gelb and Goldstein did not appear with our subjects, even at the earliest ages at which the experiment could be made.
4. Knowledge of color names apparently did not influence the selections made in the color sorting experiments.

In general we may say that the performance of deaf children in these experiments is similar to that of hearing children of a somewhat lower age level and is in no way comparable to that of the aphasic. The results therefore indicate that the thought of the deaf child, at least in regard to these color sorting tasks, before he begins to use conventional language is essentially similar in form to that of the hearing child. They indicate further that it is not distorted by imperfect or inadequate language concepts as that of the mentally retarded children studied by Peters.

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III. A STUDY OF PHONETIC SYMBOLISM OF DEAF CHILDREN

The proposition that there is an intrinsic relationship between phonetic combinations and meanings is one that has frequently been discussed in linguistics (*Cf.* Bühler, 2; von Hornbostel, 3; Jespersen, 4; Paget, 6; Sapir, 7; and Werner, 9). Advocates of such a theory in its extreme form have tried to use it to explain the origin and development of language and the relations of languages to each other. But it has not proved valid as a general explanatory principle. Statistical analyses show that there are wide distributions of sounds within single meaning categories of a given language and that a generalization which holds for one language is often contradicted by examples from another.

A more moderate point of view is one which proposes that while words come into being in very different ways and in many cases without particular reference to their sounds phonetic combinations may nevertheless have symbolic values. The experiments described in this paper were not made to test this proposition nor to discover the basis for the sound-meaning relationship. They assume that normal persons can, under some conditions be aware of the expressive character of phonetic combinations and begin with the questions: (1) whether the deaf can experience these symbolic values in their non-auditory experience of their own speech; (2) if so, whether these values that they experience parallel those of normal people whose sensory experience of speech goes so far beyond that of the deaf.

These questions have definite significance as regards fundamental psychological aspects of speech for the deaf. The deaf child learns to speak in such a way as to conform as nearly as possible to standards set by persons who are not deaf. He must carry out actions, *i.e.*, make speech movements, of which he cannot experience the full sensory results. His speech is never exactly like that of hearing people. But the very fact that he learns to speak at all means that he gets some very definite

sensory impressions from speech through his remaining senses. Our first question means, therefore, " Have the sensory impressions which are possible to the deaf any such ' color ' or ' physiognomic character ' as we experience them in our own speech? " If this question is answered in the affirmative the second becomes doubly important as we consider it in terms of making the speech of the deaf child as nearly as possible like that of people who hear.

As a first approach to the problem two preliminary series of experiments were made, one with English words and another with French and German words. The general method was to select pairs of words, contrasting in meaning, in which the difference in sound seemed to parallel the meaning differences. The words were presented to deaf children to whom they were unfamiliar. The child was taught to pronounce a pair of words, was shown by demonstration the two meanings, and was asked to tell which words and meanings belonged together. These first experiments could not yield conclusive results since they were based on the unproven assumption that for hearing persons the differences of sensory data in the pairs of words chosen corresponded to differences of meaning.[1] A qualitative analysis of the results was complicated by the fact that the two words presented in each trial were usually made up entirely of different speech sounds. One could therefore only guess which aspect of the sensory difference determined the difference in meaning in each case. Nevertheless the results were positive enough to make further, more exactly controlled experiments worth while, and on the whole they were confirmed by the results of the later more exactly controlled experiments. Following are brief descriptions of the two preliminary experiments.

Experiment I: The following pairs of words were used: rough-smooth, long-short, sharp-dull, high-low, tap-pound (verbs), round-square, sweet-sour, wool-silk, soft-hard. Of these, the first pair, rough-smooth, was used only to demonstrate the

[1] It seemed quite impossible to find an adequate control group of hearing persons for these experiments since there was always the possibility that any subject available might have heard the foreign words enough to direct his responses even if he did not actually know the language. The more limited language experience of the deaf made it seem safe to ignore this possibility with them.

procedure since some of the children already knew the word "smooth."

The experiment was made with six deaf children between the ages of 6:6 and 8:9. The number available for the experiment was small since only those who had had enough preliminary training in articulation to be taught the words and who had not been in school long enough to be familiar with their meanings could be used. Some of the children could master the pronunciation of only a part of the series, so the whole series was not given to each child.

TABLE I

RESPONSES OF SIX YOUNG DEAF CHILDREN TO ENGLISH WORD PAIRS

D indicates that the word was used to demonstrate the procedure

WORDS		rough smooth	long short	sharp dull	high low	tap pound	round square	sweet sour	wool silk	soft hard
Subject	Age									
A	(7:8)	D		+	—	+	+	+	—	
B	(6:6)	D	+	+	+		+	+		
C	(7:4)		+	D	—		+	—		+
D	(6:10)		+	D	+					
E	(8:9)		+	D	+					
F	(7:11)		+	D						

Table I gives the results of the experiment. Twenty-one trials were made in all, of which seventeen were positive,[2] and four not positive, although the protocols show that they were not definitely negative in each case. Therefore the results, insofar as they can be taken as reliable, were strikingly positive from a quantitative point of view. Equally impressive was the matter-of-fact way in which the children made their choices. It was always as though they were using names that had been ordered from the beginning, never as though they were deciding or guessing how to assign them. One felt that even if they had had the language to explain why they decided as they did in each case that a question about the decisions would have had no meaning for them. From their manner of responding they seemed to say simply that it *was* so.

Experiment II: The experiment made use of a larger group of subjects by presenting foreign words to children who had

[2] "Positive" is used to indicate choices in which the child assigned the meaning according to the conventional usage, "negative" of choices in which he reversed the ordinary word-meaning relationship.

already mastered the fundamentals of pronunciation. French and German word-pairs were used as follows:[3] aigre-douce,[4] breit-eng, stumpf-spitz, gross-klein, hell-dunkel (in the latter part of the experiment hil-dunkel[5]), kreis-eckig, schnell-langsam.

The experiment was made with 46 children between the ages of 11:2 and 18:10 years.[6] The children selected as subjects were those who were considered definitely deaf, *i.e.,* children who did not hear their own voices or understand the speech of others sufficiently, even with the aid of instruments, to have learned to speak without special instruction based on the use of senses other than hearing.

The general procedure of the experiment was the same as that of Experiment I, except that in dealing with older children it was possible to make a simple explanation in regard to the purpose of the experiment. Additional data were secured from the more mature children by asking, as often as there seemed a possibility of securing a genuine answer, "Why?" meaning "Why do you say so?", or "How did you know?" when the wording of the response made that seem the better question.

Table II gives the results in terms of positive and negative responses and the ratio of each to the total number of responses.[7] The percentages of agre-douse, breit-eng, hil-dunkel, and hell-dunkel show strikingly consistent results, in the first three cases

[3] In English: sweet-sour, wide-narrow, dull-pointed, large-small, dark-bright, circle-something with corners, fast-slow.

[4] This first pair of words was used only with part of the subjects. The experiment had to be shortened for the remaining subjects and this pair was dropped since it had already given conclusively consistent results with the smaller group.

[5] The majority of the subjects reversed the conventional word-meaning relationship with the word pair hell-dunkel. It was noticed that most of them were pronouncing "hell" with a heavy rasping vowel which made the resulting word more like the English "hull" than the clear German "hell." In the latter part of the experiment the word was presented as "hil" and the resulting pronunciation more nearly approximated that of the German word in its quality. The table shows that the change of vowel brought about complete reversal of the responses.

[6] The average age of the group was 14:39, the average number of years of school training was 8:62.

[7] The total number is often greater than the sum of positive and negative responses. This is because the subjects sometimes responded with "I do not know" or "They are the same" and in these cases there seemed to be no advantage in forcing a positive or negative response which had not been immediately felt.

in the direction of the conventional meaning of the words, in the last opposed to it. Eckig-kreis and schnell-langsam also show differences in the direction of the conventional word-meaning relationship although less great, while stumpf-spitz and gross-klein show more equal distributions of positive and negative responses.

TABLE II

POSITIVE AND NEGATIVE RESPONSES GIVEN BY THE DEAF SUBJECTS IN EXPERIMENT II

	aigre douce	breit eng	stumpf spitz	gross klein	hell dunkel	hil dunkel	eckig kreis	schnell langsam
Total Number	18	44	45	45	23	16	43	43
Positive responses	14	36	21	23	7	14	26	27
Negative responses	2	7	22	19	16	1	15	16
Ratio: Positive to total	.77	.81	.47	.51	.30	.87	.60	.63
Ratio: Negative to total	.11	.16	.49	.42	.69	.06	.35	.37

An analysis of the reasons given by the subjects for their choices serves at once to support the assumption that the choices were based on genuine physiognomic characteristics of the words and to suggest possible explanations of the cases in which choices of the deaf subjects disagreed with the conventional meaning and therefore possibly with the choices that would have been made by a group of hearing persons. Examples of these explanations are the following: For aigre-douce: "Aigre is rough. Douce is smooth." For breit-eng: " Eng is short," pointing to the mouth; " Breit is wide, my mouth . . . voice." For hil-dunkel: " It is light in the mouth. The other word . . . I feel dark in my mouth," or " It sounds high, *i* is usually high. Dunkel sounds rather dark and long." For kreis-eckig: " Because . . ." and the subject began to make jerks in the air with his finger as he spoke eckig. Or, " Because kr,kr " rolling the *r* as he made a gesture for the circle. At the same time the negative responses to the stumpf-spitz comparison were several times explained in terms of the kinaesthetic aspects of *stumpf*. Thus the position taken by the lips during the pronunciation of the vowel often seemed to be the determining factor in the comparison and was described as " sharp " or " pointed " and similarly the vowel of gross was called " small." These cases are interesting since they

involve sounds which phonetic studies have shown to have the opposite value for hearing persons.[8] That is one would expect the u[9] and the ou to be judged as larger, duller, and heavier than ɪ and ai because of their relatively lower frequency. Therefore it seems probable that some of the deaf children were influenced relatively more by kinaesthetic than by vibro-tactile sensations which would more closely correspond to the acoustic sensations of the hearing person. If this explanation for the inconsistency of responses given in these two comparisons is valid we have here cases in which the physiognomic character of the words may differ for deaf and for hearing persons.

Some of the explanations were based on superficial verbal resemblances between the word of the experiment and a familiar English word. For instance in the eckig-kreis comparison the only verbal similarity reported was that of *kreis* to *square*. With *schnell-langsam* verbal similarity was several times given to explain a positive response, for example when *langsam* was compared to *languid, lazy,* or *lonesome.* But a relationship between *schnell* and *slow* or *snail* was given to account for as many negative responses.

It was impossible to evaluate the importance of these different types of explanation since they could not be obtained from every subject for every response, and it was clear that many subjects who entered fully into the task of the experiment were unable to put into words the bases of their judgments. The explanations are of value nevertheless, in giving us some insight into the kind of data on which responses could be based and in showing that many were based on genuine experience of the sensory character of words. That there are wide individual differences in ability to recognize and also in ability to describe the symbolic character of phonetic combinations has already been shown for hearing subjects by Sapir.

[8] *Cf.* von Hornbostel, **3**; Sapir, **7**; and Newman, **5**.

[9] The symbols used in this paper are those of the International Phonetic Association as given in Webster's New International Dictionary of the English language, Second Edition, Unabridged, 1935, p. xxii. They have the following values in English words: u as in pool; ei as in cave; ɔ as in all; ɪ as in sit; i as in beet; ai as in ice; æ as in sat; *a* as in father; ou as in go.

The consistency of the results of these experiments indicates strongly that the deaf feel the physiognomic character of their own speech. The experiments cannot give a conclusive answer to the question whether this character is the same for the deaf as for persons who hear since no control experiments were made, but they point strongly toward the conclusions: (1) that for the deaf the form-meaning relationship is often in the same direction as for hearing persons; (2) that there may be words in which the part that seems most significant from a physiognomic point of view is not the same for deaf and for hearing persons, or is at least less strongly determined for deaf subjects. In such cases the physiognomic character of the word may be different for the two groups.

Experiment III: It was next necessary to make experiments by which responses of deaf and hearing subjects could be directly compared. For this purpose a technique devised by Professor Edward Sapir (7) and used in extensive experiments with hearing subjects by him and by Dr. Stanley S. Newman (5)[10] was adopted. The method consisted in presenting pairs of nonsense words, alike except for vowels or consonants to be contrasted. To each pair of words an arbitrary meaning was assigned, for instance glupi-glɪpi were given as horse, and the subjects were asked to tell whether the first of the pair of words signified to them the larger or the smaller horse. In other series the symbolisms light versus dark, cool versus warm, and light versus heavy were used.

Our procedure was to select 8 vowels, sufficiently different in quality to be clearly distinguished in the speech of deaf children, and to contrast them in pairs of nonsense words taken from, or similar to, those used by Newman. Each of the eight vowels was compared with every other one, making a series of 28 pairs. Two experiments were made with this material. In the first the symbolism large versus small was used and as in the original Sapir experiments an arbitrary meaning was assigned to each

[10] We are indebted to the kindness of the late Professor Sapir and of Dr. Newman for sending us copies of the words used in their experiments and for making suggestions about carrying out the experiments with deaf subjects.

pair of words. A second series used the symbolism bright versus dark with the same nonsense words and in this series we found it inadvisable to introduce object names. A few trials showed that there were very few objects that were naturally thought of as either bright or dark, and that to ask the deaf child to distinguish a bright book or chair or horse from a dark one was to introduce an element of improbability that broke down his otherwise matter-of-fact acceptance of the task.[11]

Following is a list of the nonsense words used in the two experiments with the arbitrary meanings used in the large-small comparison:

A.	glupi	glɪpi	horse
B.	leigo	lɔgo	apple
1.	mɪli	mili	bottle
2.	bɔz	beiz	dish
3.	glaiva	glɔva	knife
4.	b*a*da	bɪda	coat
5.	leidu	lædu	rug
6.	m*a*bu	mibu	towel
7.	bluva	bleiva	chair
8.	zila	zula	tree
9.	læba	laiba	bicycle
10.	zɔli [12]	z*a*li	baseball
11.	flɪga	flaiga	automobile
12.	meiba	miba	watch
13.	vægu	vɔga	clock
14.	mɔgu	mɪgu	show
15.	tɪvu	tuvu	scissors
16.	glufi	gl*a*fi	lamp
17.	flɔba	fliba	box
18.	blɪgu	bleigu	pencil
19.	jil	jæl	book
20.	n*a*du	naidu	trunk
21.	seiba	s*a*ba	boat
22.	tuzi	tæzi	hammer
23.	mailu	meilu	house
24.	vuga	vaiga	train
25.	sæba	sɪba	dog
26.	jɔl	jul	skates
27.	bl*a*va	blæva	picture
28.	diba	daiba	desk

[11] Since Sapir explained that the introduction of the arbitrary meanings served only to make the task more real the change seemed justified in this case in which it had the opposite effect.

[12] In the large-small experiment the ɔ–*a* comparison was given twice, once as *10* and once as *27* while the æ–*a* was omitted. This error was corrected in the bright-dark series.

The pairs of words were presented to the children typed on small cards with spelling following that of the phonetic charts in use in most schools for the deaf in America. The Sapir-Newman experiments had been made with groups. Ours had to be made as individual experiments since, with deaf children, one could not take the pronounciation for granted. It was necessary to hear each child pronounce the pair of words in order to be sure that the vowels on which he based his judgment approximated the ones intended as nearly as possible. A few records were thrown out because the pronunciation of the subject was so inconsistent as to change the experiment completely.

The following instructions were given in writing before each experiment began: *For large-small:* I want to play a game with some make-believe words. I will give you two words for horse. One is small horse. One is large horse. Please read them, then *guess* which is large horse. I want to know how they seem to you. *For bright-dark:* This is another game with make-believe words. There will be two words each time. Please say them aloud, then tell me which means bright, which means dark.

It will be noted that in the first experiment only the word *large* was asked for whereas in the second both words were brought in. This was done because most of the children gave *small* as well as *large* in the first and it seemed apparently a little more natural to them that the experimenter should ask for both statements.

In some cases a subject responded with "I don't know" or "They are equal." The instructions did not suggest the possibility of these answers, but when they were given they were always accepted as satisfactory and the subjects were never urged to make choices.[13]

All the subjects who took part in the bright-dark comparison

[13] This point is mentioned since Bentley and Varon (1) have questioned the validity of parts of Sapir's work on the ground that his choices were forced. In our experiments failure to give either positive or negative responses were sufficiently frequent to make it clear that the subjects did not feel any compulsion to give a response that was not a genuine one; yet considering the fundamental difference between the data on which our subjects and those of Sapir and Newman made their judgments the results are strikingly similar.

had already acted as subjects for the large-small comparison, about six weeks earlier.

The large-small comparison was made with three groups of deaf children, advanced pupils from two different schools for the deaf, which will be designated as School I and School II, and pupils from the intermediate grades of School I. This younger group did not prove satisfactory as subjects. It was obvious that many of them did not understand the experiment and wholly failed to enter into it. (For instance some alternated first and second words of the pairs in making their choices, others chose either the first or second words each time, etc.) Because of the difficulty in distinguishing between the few who made real choices and those who did not we decided not to include the responses

TABLE III

DEAF SUBJECTS WHO TOOK PART IN THE LARGE-SMALL AND BRIGHT-DARK COMPARISONS

School	Department	Number of Subjects	Average Age in Years
Large-small			
I	Advanced	30	16.68
I	Intermediate	34	13.13
II	Advanced	28	17.74
Bright-dark			
I	Advanced	32	16.89

of this group in the statistical treatment of the results and did not attempt to make the bright-dark comparison with them. It was also omitted with School II which was at a considerable distance and could not be visited for the second series of experiments.

Table III gives the numbers and average ages of subjects in the three groups of deaf children with whom the experiments were tried.

Following Newman (5, p. 66) the data of the experiment were treated according to a statistical method devised by L. L. Thurstone (8). The first step in this procedure is to get the "experimental proportions" for each pair of words; for instance with the pair mıli-mili to determine in what percentage of cases mıli is called the larger, in what percentage mili is called the larger. These experimental proportions then had to be converted

into sigma scores on a normal distribution curve. One then has sigma values for the comparison of each vowel with every other one of the series. Scale separations are computed according to a formula given by Thurstone and the scale constructed by accumulating scale separations.

Table IV gives scale values for the large-small comparison, for hearing subjects as determined by Newman, and for the two

TABLE IV

SCALE VALUES: LARGE-SMALL COMPARISON

	Hearing Subjects	School I	School II
ɪ	.0000	.000	.000
i	.2687	.745	1.1515
ei	1.0370	1.351	1.2525
ai	1.1029	.975	1.2865
æ	1.1045	.335	.426
u	1.4061	.835	1.109
a	1.6544	1.153	1.2235
ɔ	1.7047	1.524	1.4355

groups of deaf subjects. Figure 1 shows these results graphically. The vowels are arranged in order according to the large-small symbolism. We see that for normal subjects they follow the general order of decreasing characteristic frequency, that is i and ɪ which are described as smallest have the highest characteristic frequency, ɔ, *a* and u have the lowest. The two exceptions to an absolutely regular frequency order are i, which according to frequency alone should have been treated as smaller than ɪ, and u which according to frequency should have been the largest. Newman believes that three other factors, tongue position, vowel length, and size of the oral cavity are also effective in determining the symbolic character of a word. He explains the two exceptions, insofar as they are significant, in terms of these factors.

The results obtained for deaf subjects indicate: (1) We are able to obtain a definite patterning of speech sounds in terms of phonetic symbolism. This indicates that there is a considerable degree of differentiation in the non-acoustic sensory data on which the speech of the deaf must be built up, a fact which

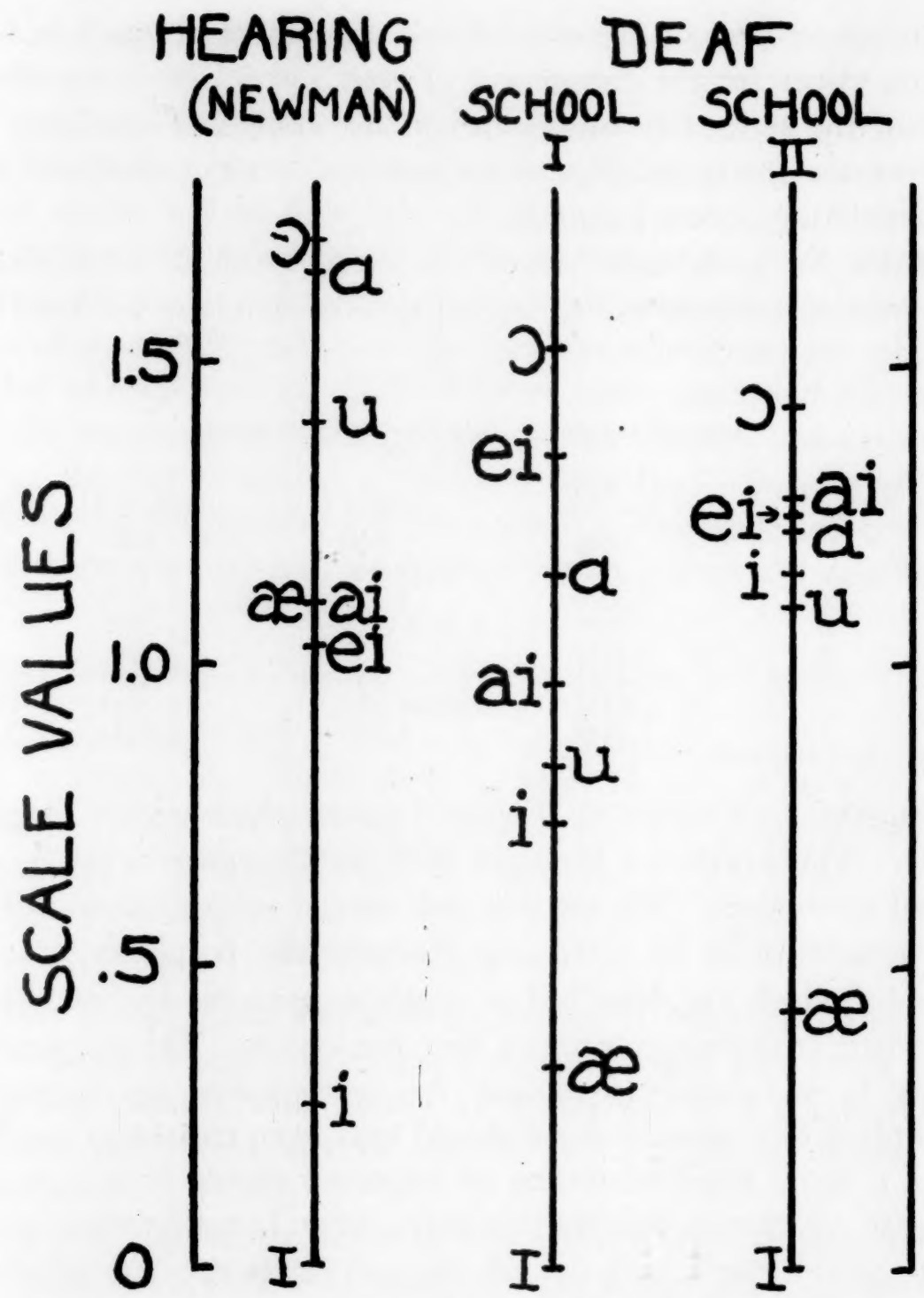

FIG. 1. Scale values for vowels in the large-small comparison.

has some importance for the teaching of speech to the deaf. (2) There is a close agreement in the rankings made by the two schools for the deaf although the scale separations are greater for School I than for School II. This difference in amount of scale separation is probably to be explained by the observation of the experimenter that the speech of School II was less accurate

and showed less differentiation in the pronunciation of the vowels than that of School I. The corresponding lack of distance in scale separations for this group is an indication that the relation between the choices made by subjects and the sensory quality of words is a genuine one. Table V, which shows rankings of vowels for the three groups on the large-small scale with differences between the normal and the two groups of deaf subjects, indicates that the average difference in rank between deaf and hearing subjects is also greater for School II, another evidence

TABLE V

DIFFERENCES IN RANK FOR DIFFERENT VOWELS BETWEEN DEAF AND HEARING SUBJECTS ON THE LARGE-SMALL SYMBOLIC SCALE

	Rankings			Differences in Rank Between Deaf and Hearing		
Vowels	Hearing Subjects	School I	School II	School I	School II	Average Difference in Rank Between Deaf and Hearing
ɔ	8	8	8	0	0	0
a	7	6	5	1	2	1½
u	6	4	3	2	3	2½
æ	5	2	2	3	3	3
ei	4	5	7	1	3	2
ai	3	7	6	4	3	3½
i	2	3	4	1	2	1½
ɪ	1	1	1	0	0	0
			Ave.	1.5	2.0	

that the speech of that group deviates more from the normal. (3) There is a rough agreement between deaf and normal subjects: ɔ is judged as largest in both groups, ɪ as smallest. But there are also differences. The deaf judge u as relatively smaller than do normal subjects. At the same time æ which normal subjects judged a little larger than ei and ai is placed near the bottom of the scale with ɪ by the deaf, and i is treated as relatively larger.

How are these differences to be explained? The results of this experiment seem to confirm those of Experiment II that certain more specific kinaesthetic factors than those suggested by Newman may be more significant for the deaf than for hearing subjects. Thus we find again that the u which subjects in

Experiment II characterized by the lip-contraction is treated as smaller by deaf than by normal subjects. Although Newman did not consider this factor in treating his results it seems possible that it played a part in the displacement of the u from its position on a strict frequency scale for normal subjects.

Likewise it seems that kinaesthetic factors may have played a part in the placement of æ by the deaf. The tongue position for that sound is relatively rigid and tense, for ei and ai relaxed, a difference which one can believe would be effective in determining a large-small symbolism.

i as we have seen was displaced from the simple frequency ranking with hearing subjects. Newman suggested that the factor of vowel length probably accounted for this. This same factor was also probably effective with the deaf. It is also likely that in this case a difference in pronunciation similar to that which affected the hell-dunkel judgment in Experiment II was effective.

Thus we see that while characteristic vowel frequency seemed to be the most important general factor involved in the choices of both deaf and normal subjects kinaesthetic data apparently played a relatively greater part in some cases with the deaf. This is to be expected when we consider that the experience of frequency can be of either acoustic or vibro-tactile data and doubtless affected normal subjects as both. But we know that the threshold for vibro-tactile stimulation is higher than for acoustic stimulation. It is therefore quite probable that frequency as a determining factor will be less impressive for the deaf, other data relatively more so, when as in the case of our experiments, it is directly related to the symbolism under consideration.

The rankings of deaf and normal subjects on the bright-dark symbolic scale bear out this suggestion (*Cf.* Tables VI and VII and Figure 2). We see that for normal subjects the arrangement of the vowels followed the order of decreasing characteristic frequency without exception: i was judged as brightest, u as darkest. Newman (**5**, p. 67) explains the differences between these results and those of the large-small comparison by saying that there is no longer a direct relationship between symbolic meaning and other factors as with i where he felt that vowel

length was directly related to the symbolic meaning " large." If this explanation is valid one would now expect a closer agreement between deaf and normal subjects. This is the case. The average rank displacement for the large-small comparison with School I was 1.5, for bright-dark 1.0. The only serious deviation between the two groups is now for i, for which there is

TABLE VI

SCALE VALUES: BRIGHT-DARK COMPARISON

	Hearing Subjects	Deaf Subjects School I
i	.0000	.60
ɪ	.1918	.05
ai	.3520	.00
ei	.5736	.54
æ	.8752	.70
a	1.1534	1.05
ɔ	1.3247	1.50
u	1.6531	1.39

reason to believe that there is a definite difference in pronunciation between the two groups.

It is interesting to consider these results in terms of other work on the symbolic character of speech sounds. Von Hornbostel discusses the relation between sound and meaning and the part that this relationship plays in the process of understanding other people. He says that it is not the specific qualities of single sense spheres that are important for the word-meaning relationship,

TABLE VII

DIFFERENCES IN RANK FOR DIFFERENT VOWELS BETWEEN DEAF AND HEARING SUBJECTS ON THE BRIGHT-DARK SYMBOLIC SCALE

	Rankings		Differences Between Deaf and Hearing Subjects in Rankings
Vowels	Hearing Subjects	Deaf Subjects	
u	8	7	1
ɔ	7	8	1
a	6	6	0
æ	5	5	0
ei	4	3	1
ai	3	1	2
ɪ	2	2	0
i	1	4	3
			1 Average Displacement

but rather the character of the whole process, for instance that it is bright or dull, increasing or diminishing, sudden or gradual. He believes that in this sense the pattern of auditory speech is

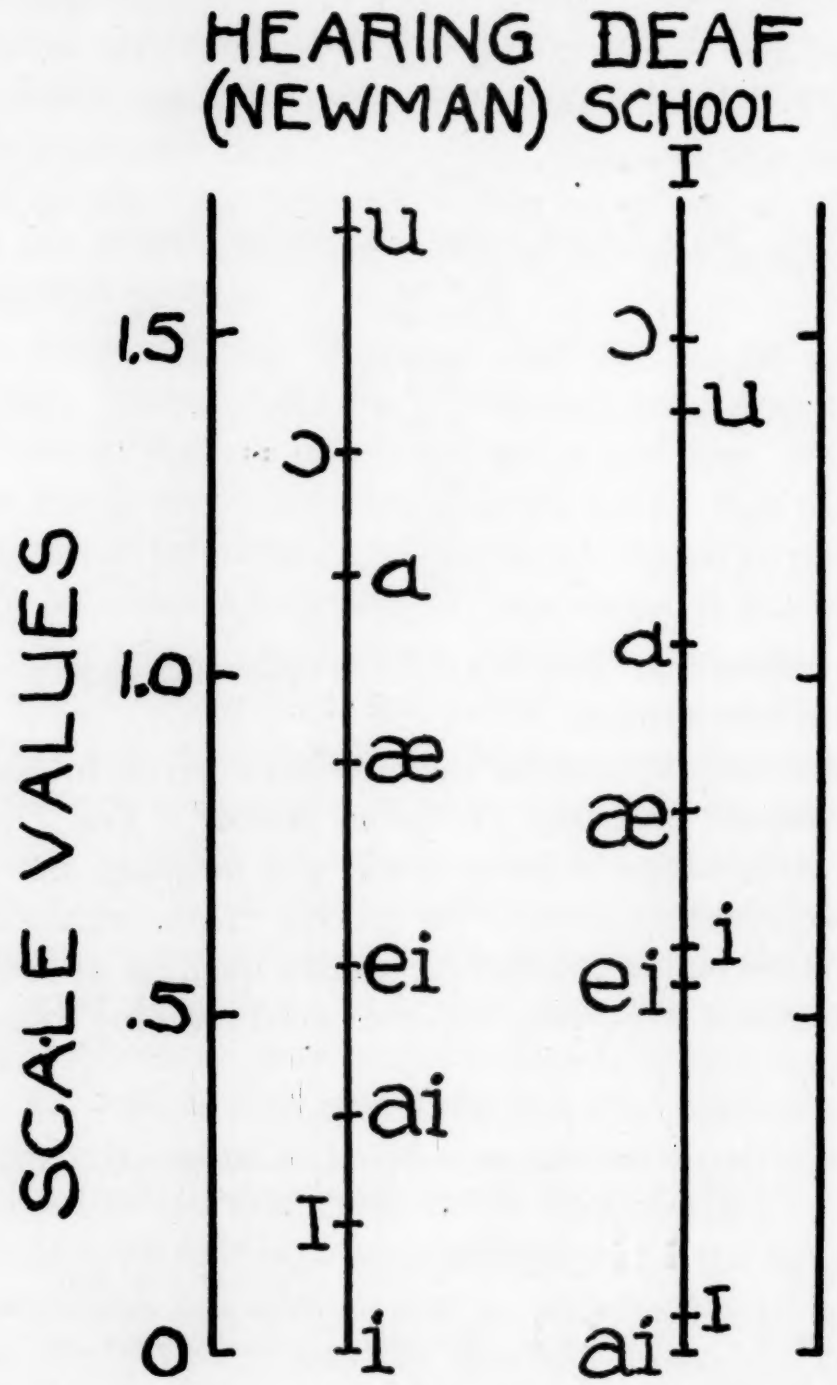

FIG. 2. Scale values for vowels in the bright-dark comparison.

similar to that of the movements by which it is produced and says that it is idle to ask in which modality the original meaning of a given sound lies for it is common to all modalities. Paget also, in his gesture theory of the origins of language, suggests a

physiognomic similarity between sound and movement. The results of these experiments with the deaf, insofar as they are to be taken as valid, give evidence which seems in opposition to this point of view. That is, they show cases in which the movements involved in making a sound may carry a symbolic character at variance with that of other sensory data. The displacement of the u on the frequency scale in Newman's experiments with normal subjects points in the same direction. But these experiments cannot be taken as final proof of such a discrepancy since no exact measurements were made of the speech of the deaf subjects to rule out the possibility that the differences between their judgments and those of normal subjects were the result of differences in the spoken form of the word, such as apparently affected the results of the hell-dunkel comparison.

But regardless of whether a more careful analysis of the speech of the deaf and normal persons would change the interpretation of that aspect of the results, the important fact remains, that the sensory data of the deaf are so far differentiated that it is possible for them to feel the symbolic value of spoken words much as hearing people do. This suggests that a study of the way in which the deaf child can use these speech data might help in teaching him to "feel" what he is saying, to make his own speech more directly expressive, and to build up his own standards for the quality of his speech.

A single example from Experiment I may serve as an illustration of the possibilities. In the comparison of "tap" and "pound" one of the subjects in the preliminary training on the pronunciation was repeating the two in the same rather low, flat tone. The teacher who was present commented, "She will never get the meanings for there is so little difference in the way she speaks the two words." The experimenter proceeded and showed the child the meanings, which she applied correctly. Then to see what would happen she asked her to repeat the words several times. At once the pronunciation changed. "Tap" became more light and soft, while "pound" without being exaggerated, took on a richer resonance. The two words became at once more expressive and more intelligible.

In addition to showing that the deaf can feel these symbolic values of speech as normal people do, these experiments suggested that there are probably differences between the speech data of deaf and of normal persons aside from the absence or presence of acoustic material. These differences suggest the possibility that some of the persistent mispronunciations of the deaf may be individual deviations toward something that feels more suitable or more satisfying than the word as it is taught. This would indicate that the teacher of speech in a school for the deaf, in trying to correct incorrect speech may in some cases be working not only against failure to remember what has been taught but also against a preferred speech pattern. At the same time it is probable that if there are preferred speech patterns in this sense they have to be explained also in terms of the original speech training given to the individual in question and of the general factor of ease of pronunciation. In these respects the deaf differ from normal persons as much as in the aspects of speech experience studied in this paper, that is, in the character of the sensory speech data.

Summary

1. It has been shown that phonetic combinations can have symbolic values. Experiments described in this paper were made to determine: (1) whether the deaf can experience these symbol values in their non-auditory experience of speech; (2) if so, whether the values that they experience parallel those experienced by hearing persons whose sensory experience of speech goes beyond that of the deaf.

2. Three series of experiments were made. In Experiments I and II deaf subjects were taught to pronounce pairs of unfamiliar words. Two meanings were then shown by demonstration and the subjects were asked to match words and meanings. In Experiment III the subjects were asked to pronounce pairs of nonsense words contrasting a series of eight vowels and were asked to tell in each case which of a pair represented the larger of two objects. In a second trial they were asked which represented the brighter and which the darker of two objects. For

this experiment comparable data from hearing subjects were available.

3. Results from these three series of experiments indicate: (1) that the deaf can experience the symbolic character of their own speech; (2) that their experience is in many cases similar to that of persons who hear; (3) that probably there are cases in which there is a difference between the symbolic character of phonetic combinations for deaf and for hearing persons.

4. These differences can be directly traced to the lack of the auditory factor in the sensory data of the deaf and to the greater significance of kinaesthetic factors.

5. The differences that exist between the symbolic character of speech for the deaf and for the hearing suggest the possibility that some of the mispronunciations and wrong accent and rhythm in the speech of the deaf may be a shift toward a subjectively better speech pattern rather than simple failure to remember what has been taught.

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IV. A COMPARISON OF SENTENCE STRUCTURE OF DEAF AND HEARING CHILDREN

I. Introduction

The deaf child usually does not begin to learn language until he has reached an age at which the hearing child has already mastered most of the forms used in adult expression. The whole process by which he learns language is necessarily different from that of a hearing child. From the beginning it is based to a certain extent on the presentation of carefully selected examples from which rules can be derived, while the hearing child learns by free selection from a wealth of language forms. In spite of these differences the deaf learn to express themselves freely in the language of their social milieu. It is often quite impossible to say of a single composition whether it was written by a deaf or by a hearing child.

At the same time, where there are such far reaching differences in the development of a function there must also be fundamental differences in the result. The deaf make a larger number of errors in the use of language than the hearing. There are also differences in style, especially in sentence structure and the way in which words are employed, differences that cannot always be defined in terms of a single piece of writing, but which are nevertheless significant for the language and thought structure. In this study an attempt is made, by comparing a large number of compositions written on the same subject and under similar conditions by groups of deaf and of hearing children, to describe some of these differences more exactly than has been done before and to consider their psychological significance.

II. Survey of the Literature

As far as we know only two attempts have been made to compare the mastery of sentence structure by deaf and hearing

children. One was a brief study by Wollermann (36) of a completion test devised by Lipmann to determine the relative difficulty of connectives introducing a series of subordinate and coördinate clauses. The other by Huber (14) was an analysis of language used by deaf and hearing children to describe pictures.

A number of developmental studies have been made of the language of normal children which are important for any comparison of normal with deaf children, since they help explain the direction of the differences that are found. The earliest experimental work of this kind is probably that of Lipmann (18) referred to above. Lipmann gave his test to 2256 subjects, but published only a small part of his data, probably because his preliminary analysis showed that the test itself was not planned systematically enough to yield full results. Minkus and Stern (21) used Lipmann's method to make a more systematic investigation of the use of connectives. Their quantitative results, based on the responses of forty children at each of four different age levels gave an interesting rating of the order of difficulty for twenty-three different German connectives. Their analysis of their data gives an insight into psychological problems of sentence structure which is very important in that it stands almost alone as an attempt to study the problem at that level. The monograph on children's speech by Clara and William Stern offers a further analysis of psychological problems of language development (32).

In America and England developmental material has come chiefly from two sources, first from observational and experimental studies of language development in young children; second from curriculum studies made with older children in an effort to compare what is taught in school with what people actually use, and to adjust the curriculum in such a way as to emphasize the skills which are most frequently needed. Some of this latter work has consisted exclusively of error studies; other investigations, which are more closely related to our problem, have dealt with the occurrence of different language forms at different age levels. Following is a brief summary of the principal work from these different sources.

Nice (22) was one of the first to study the relation of sentence

length to other aspects of language development. From an analysis of case studies (about twenty from the literature and her own work) she distinguished stages of development in length of sentence and showed a relationship between these stages and general vocabulary development. Smith's monograph (30) on development of vocabulary and length of sentence in young children is one of the most important statistical studies for the pre-school period. She followed up this investigation by a special study of factors influencing development of sentence length in pre-school children and showed that children use longer sentences in conversation with adults than when they are playing with other chlidren (31). McCarthy (19) under somewhat different experimental conditions obtained results in which this aspect of the situation was not significant. McCarthy's longer study of language development in pre-school children (20) and Day's study of language development in twins (8) give further data about sentence length and also about kinds of sentences used at different age levels.

Davis (6) followed the methods used by Day and McCarthy to compare linguistic skill of twins, singletons, and siblings (ages five to nine years). She compared her norms for length of sentence, type of sentence, and frequency of different kinds of clause with those of the preceding work. Several of these studies have shown the significance of environmental factors, especially socio-economic conditions, for language development.

In another study of the same data Davis (7) compared developmental curves based on the mean of the five longest sentences used by each child and curves showing the proportion of one-word responses with curves of mean sentence length. She believed that the mean of the five longest sentences showed development more clearly than any other single measure of sentence development.

Boyd's study of the development of sentence structure in childhood (4) shows the kind of sentences used at different ages and the development of clauses distinguished according to the three principal grammatical categories (noun, adjective, and adverb) for the years from three to eight. Boyd made extensive

records of the speech of one child and compared these data with adult conversation from novels.

One of the first statistical studies of the frequency of subordination and of types of dependent clause used by older children was an analysis of 10,000 sentences from fourth grade through high school and adult level published by Stormzand and O'Shea in 1924 as part of a larger curriculum study (33). The authors measured sentence length and compared the frequency of different kinds of sentences and clauses at different age levels to determine what grammatical categories should be stressed in school, and at what ages.

A more recent developmental study is LaBrant's analysis of 986 compositions written by children in grades four to twelve, inclusive, and of selections from writings of twenty-one eminent psychologists (16, 17). LaBrant used the finite predicate as her unit of measurement and was especially interested in the relation of subordination to chronological age, mental age, and I.Q. She studied the distribution of her subordinate predicates according to the function of the clauses in which they occurred and made an attempt to show further qualitative differences between grammatical forms of younger and older children.

Anderson (1) criticized LaBrant because she did not check the consistency of her subordination index [1] by comparing different compositions written by the same children. He compared five different selections from 111 college students and found that measures of length of sentence and the subordination index showed low positive correlations in the different material. He believed that the subordination index was especially unreliable because of the extent to which subjective factors entered into its determination. Of two readers who worked on his material, one obtained a subordination index of 50 and one of 38, the differences resulting from differences in the handling of the infinitive which he said LaBrant had not made clear. This criticism seems unjustified, since LaBrant stated explicitly that she was dealing with *finite* predicates in determining her subordination index (*Cf.*

[1] LaBrant's term for the ratio of the number of verbs in dependent clauses to the total number of verbs.

her discussion: **16**, page 398; also her classification of *finite* verbs on page 412). It seems the more definite when she defines the class of infinitives, which she treats separately, as including " all verbs which are not finite " (p. 413). This definition does not make it quite clear how she handles the participial and gerundive constructions but that has no bearing on the question raised by Anderson.

The question of the reliability of data based on single short samples of language we will discuss in connection with the limitations of our own material.

Hoppes (**12, 13**) at about the same time made an analysis of material from 368 children of grades three, four, five, and six of public schools. His study included a comparison of length of composition in sentences, of sentence types, of the number of words in the different types of sentence, of subordinate clauses, and of the ratio of coördinate to subordinate clauses at different age levels.

Seegars (**28**) studied the influence of form of discourse on the incidence of the different types of subordinate clause in 604 compositions written by children in grades one through six. He found differences between argumentation and the other forms in the kinds of clauses used. Wiswall (**35**) found little relation between the kind of sentence used and topic assignment of 800 eighth grade compositions.

Huth (**15**) worked with 57 German children (ages 4½–6 years) to study the process by which the child masters the use of complex forms. Bloch (**2, 3**) based an analysis of this process on observations of three French children and discusses the time of appearance of different forms of subordination. Woodcock (**37**) discussed the first appearance of different question forms in records of children's conversations.

Deutzing (**9**), in making a comparison of written and oral language of 20 German boys, studied the proportions of each type of sentence and the average number of clauses per sentence at four different age levels.

Thorndike (**34**) has made a study of frequency of occurrence of English constructions which includes some of the forms involved in our own material.

Thus we see that there is a considerable amount of literature which gives norms as to development of sentence length, of relative frequencies of different kinds of sentences, of degree of subordination, and of kinds of subordinate clauses in relation to variables such as age, social level, I.Q., mental age, and momentary situation (including topic assignment). Psychological analyses of these data are, however, rather meager. This lack seems especially important in the treatment of the kinds of subordinate clauses. The differences which we found between deaf and hearing in the use of clauses can only be understood if one first understands the psychological character of the conceptual relation which the structure represents, and analyzes its grammatical form in psychological terms.

III. Material of This Study

The material of this study consists of 1,118 compositions, accounts of a short motion picture [2] written by the deaf and hearing children, each of seven different age groups, hearing children from eight to fourteen, inclusive, deaf children from eleven to seventeen, inclusive.[3] For both deaf and hearing the first age group represents the youngest children who were able

[2] We want to thank the group who worked with us in making the motion picture, Mrs. A. I. Tullis and Mr. Nils Bergstrom who helped plan and dramatize the story, and Dickie Oiesen who played the principal part in the drama.

The story of the motion picture is, briefly, as follows: A little boy runs up on a porch, knocks at a window, and asks his mother for a banana from a bowl of fruit on a table inside the window. The mother gives the boy one banana but refuses his request for a second. The boy eats his banana, goes back twice, and helps himself to more. He then begins to feel the bad effects of overeating. The mother finds him, administers a dose of medicine, and takes him into the house.

[3] The motion picture was shown in three schools for the deaf, The North Carolina School for the Deaf at Morganton, The Pennsylvania School for the Deaf at Mount Airy, and the Clarke School. It was also shown in three schools for hearing children, the Vernon Street and Florence public schools in Northampton and in public schools at Amherst, Massachusetts. Each of these six schools represented a fair cross-section of the population. In each school the groups to whom the picture was shown were told that they would see a short motion picture story, that it would be shown twice, and that after they had seen it they would return to their regular seats and write the story. Observations of the children while the picture was being shown, as well as the character of the results, makes it seem that the motion picture material, in spite of the simplicity of the story itself, was sufficiently entertaining to get the real attention of older as well as younger children.

to write the whole story. We are thus comparing deaf children with hearing children who are three years younger. Actually the educational retardation of the deaf is greater than three years (*Cf.* Pintner, 24 and 25; Reamer, 26) but it would have been difficult to make an exact comparison. There is little correspondence between the grading in schools for hearing children and for deaf children, or even between different schools for the deaf. If achievement test ratings had been available for the whole group they would have been helpful, but on the whole it proved not to be very important at what points the two groups coincided in educational and mental ages. We were concerned more with the course of development within each group and with a comparison of the groups from this point of view than with a comparison in terms of absolute achievement from year to year. And the curves are sufficiently different in the comparisons that are most important to make trends clear in spite of the lack of exactness of our knowledge as to the points at which the curves correspond.

Our material, like LaBrant's, included only a single composition from each child represented in our study. The subject and the form of the composition were limited by the way in which the material was obtained even more than was the case in LaBrant's study. In her work the children, instead of being given a prescribed story to put into words, were allowed to write freely about a subject. The subject was not even exactly the same for the elementary and the high school children from whom material was obtained. What do these limitations mean for the validity of our results? They mean, obviously, that neither we nor LaBrant obtained indices which may be considered norms for the ages that we studied. We can say, however, that we obtained measures of the use of subordination and other language forms in a certain kind of material. There is no doubt that the consistent differences which we found between older and younger children and between deaf and hearing children in this material are significant for language in general, although it is to be expected that the absolute amount of the differences and of the frequency with which different forms were used was largely

determined by the kind of material that we studied. Even the relative frequency of some forms in the compositions of the deaf and hearing might be different in different material. For instance in our narrative material the deaf used causal clauses relatively more often than the hearing, although they used dependent forms on the whole less. But with material involving argumentation, in which the percentage of causal clauses would be higher for both groups, the relation between the two groups might be quite different.

Exactly how the results of this study would compare with results from different kinds of material obtained from the same or different children is a question that can only be answered by actual studies and by tests for particular language forms. But for our own introductory comparison of deaf and hearing children of different ages, the limitation of content imposed by our technique was an advantage. Our material could to some extent answer the definite question: "Given a certain event to describe in words, what language forms will be used?" It was easier to compare a series of causal clauses, for instance, all of which were used in regard to the same situation than to compare causal constructions used in regard to different situations. And certainly the frequency with which any kind of clause was used could only be determined by taking into account the extent to which the situation called for it. More comprehensive results can probably be best obtained by combining the results of a series of such limited studies with material obtained from tests.

IV. Quantitative Analysis of the Material: Average Length of Compositions in Words; Average Length of Sentences

Table I shows the distribution, according to ages and schools, of the material used in this study. It will be noted that two age groups are not included (11 years, School 3, Deaf; 14 years, School 1, Hearing). These two groups are missing because the picture was not shown to children below twelve years in the first case, nor to a class which included the major group of fourteen-year-olds in the second.

TABLE I

DISTRIBUTION OF MATERIAL BY SCHOOLS AND AGE GROUPS FOR DEAF AND HEARING CHILDREN

Hearing School	Ages 8	9	10	11	12	13	14	15	16	17	Total
1	23	27	23	32	37	44	..				
2	24	34	27	26	39	33	30				
3	28	39	42	51	79	95	84				
Total	75	100	92	109	155	172	114				817
Deaf											
School											
1				11	11	9	8	14	7	6	
2				18	11	15	17	13	8	12	
3				..	6	12	21	27	32	43	
Total				29	28	36	46	54	47	61	301

Table II and Figures 1 and 2 show the average length of composition in words and the average length of sentence for deaf and hearing children.

On the whole the sentences were clearly enough marked off to make the count a reliable one. In cases in which it was difficult to determine the number of sentences because of inaccurate punctuation and capitalization, we used a system of division that seemed to agree with the structure of the material as a whole. Thus in distinguishing between simple and compound sentences the subject was the decisive factor:

He ate it. And he went back for another. This is accepted as it is written, as two sentences.

He ate it. And went back for another. This is treated as one sentence, since (1) the subject of the second verb is omitted and (2) it is the same as that of the preceding sentence.

He asked for it. And gave it to him and closed the window. This case is treated as two sentences, because the omitted subject of the second clause is not that of the preceding one but another person (in this case the mother).

Similarly in cases in which the difficulty arose from the absence of punctuation: *Then he got sick his mother came out.* This is treated as two

TABLE II

AVERAGE LENGTH OF COMPOSITION AND LENGTH OF SENTENCE FOR DEAF AND HEARING CHILDREN, BY AGE GROUPS

Hearing Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Average words per story	112	134	144	142	166	182	162				154
Average words per sentence	10.2	10.9	11.1	11.1	12.8	13.7	13.9				12.2
Deaf											
Average words per story				130	130	164	151	174	178	184	164
Average words per sentence				7.9	8.0	9.0	8.4	9.6	9.5	10.2	9.2

sentences, since the subject is different in the two parts and there is no connective.

He got sick he put his hand to his head. This is treated as one, since the subjects of the two verbs are the same.

An exception was made to this rule in the few cases in which clause after clause was run together. Thus: *He went back and looked in the window and looked around and did not see anyone so he took another banana and ate it *he kept on taking it and finally he got sick *his mother came out.* In this case both clauses (*) introduced without connectives were treated as beginning new sentences.

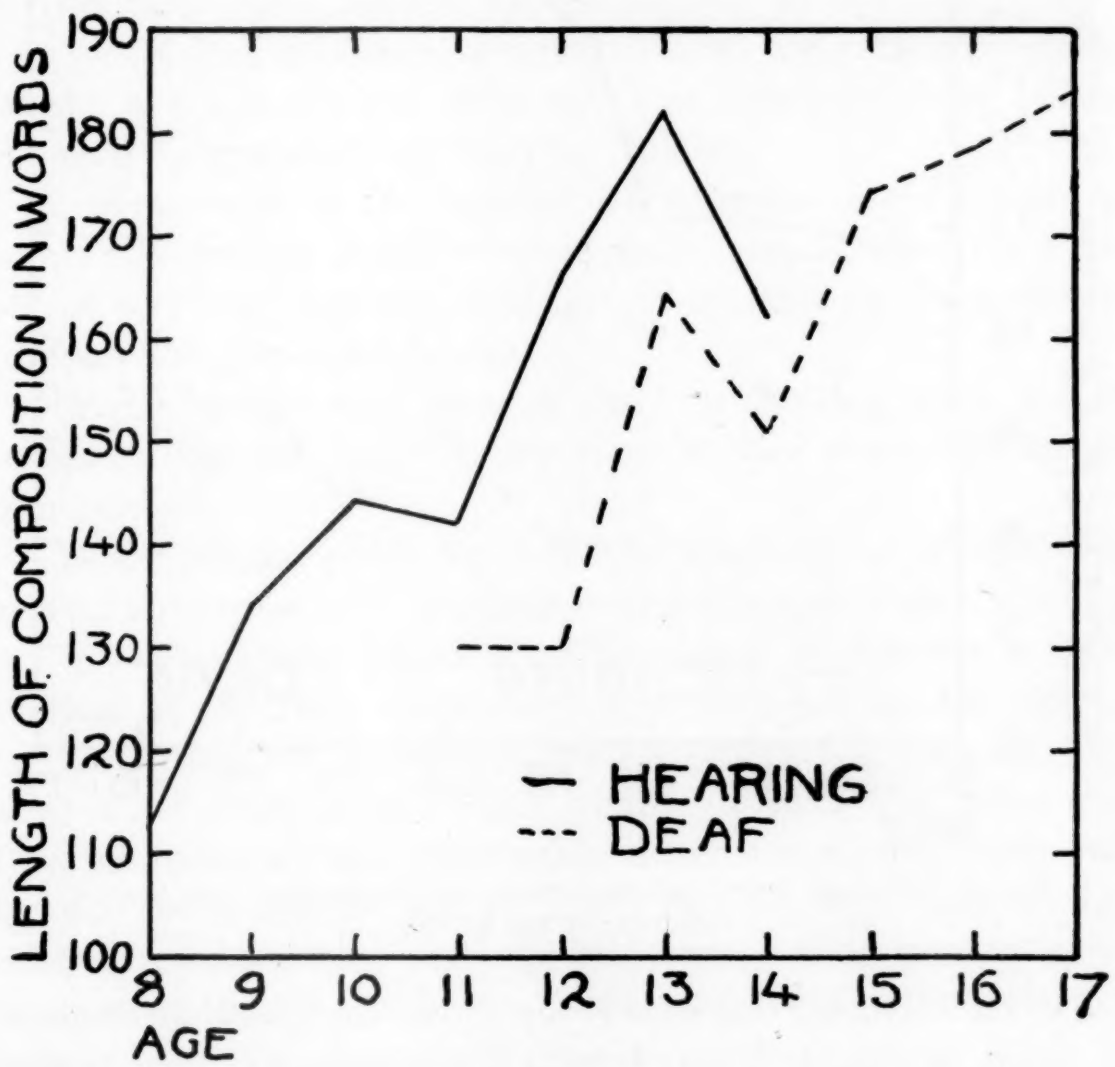

FIG. 1. Average length of composition in words for deaf and hearing children by age groups.

The following examples illustrate the rules that were applied in distinguishing between compound and complex sentences: *When she saw the boy and so she went into the house and got the oil. After he got a stomach ache and his mother went in the house.*

These are treated as compound sentences, *after* and *when* being classified as simple adverbs (wrongly used), since the use of *and* before the second clause makes the complex structure impossible.

After he had ate that one. He got his second. This is treated as a single complex sentence since, orally at least, it conforms to that structure.

These data show that there is a definite relation of composition length to age. For both deaf and hearing children, compositions of older children are longer than those of younger ones. The drop at 14 years for the hearing cannot be explained from our material, since the curve does not continue beyond that age.

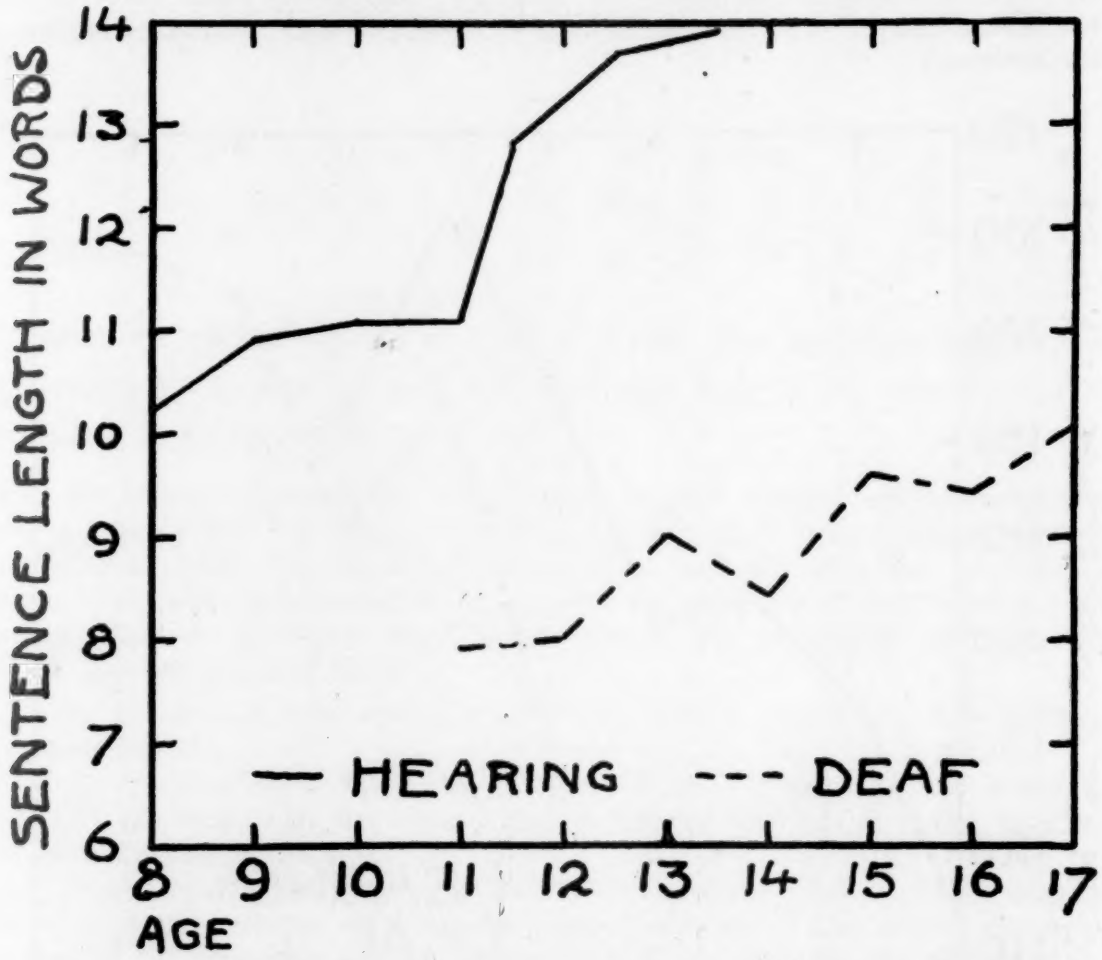

FIG. 2. Average length of sentence in words for deaf and hearing children, by age groups.

Other data indicate that that group shows continued development in other respects, so it may be that a maximum had been reached for length of composition in the telling of the particular story under consideration. The difference between deaf and hearing in this comparison is not great. According to absolute age, for the four parallel age groups, the compositions of the deaf are shorter, but if we compare the youngest deaf with the youngest hearing children (and so more nearly equalize language experience), we find that the compositions of the deaf are longer. The curve continues to rise in the higher age groups of the deaf and

the final average for the seven years is higher for deaf than for hearing. But the difference is not great enough to be considered important in the absence of a more definite basis for comparison.

In regard to length of sentence, on the other hand, we see (1) that older children use longer sentences than younger ones; and (2) that hearing children use longer sentences than deaf ones. The difference between deaf and hearing is unambiguous in this case, since there is no overlapping of the two groups. The oldest deaf children (seventeen years) use sentences which, on the average, are not quite equal in length to those of the youngest (eight-year-old) hearing children.

A comparison of the number of sentences per composition would add nothing to comparisons already made, since the number of sentences depends on length of sentence in compositions of approximately equal length.

Huber's results also showed that the hearing used longer sentences than the deaf. In his material they also wrote longer compositions.

The differences which we found in length of sentence are in general agreement with developmental differences shown in other studies. The Sterns discuss growth in length of sentence in their analysis of children's speech, and Nice demonstrates the significance of changes in sentence length for general language development in her compilation of case studies. Smith, McCarthy, and Day, all found a close relationship between sentence length and age for the pre-school years. Davis verified these findings for children through nine and one-half years. For written composition at higher age levels Stormzand and O'Shea found a progressive yearly increase from 11.1 words at fourth grade to an adult average of 20.9. LaBrant's study gave ample confirmation of this general trend. Hoppes reports that the average length of sentence written by sixth grade pupils was 40–60% greater than that written by third grade pupils. Our average fourteen-year-old hearing children is 13.9, somewhat below the 17.3 words per sentence which Stormzand reports for his high school freshmen (who must have been about the same age). The absolute length is, however, probably determined by other

factors, such as the nature of the composition itself, and is less important than the age development. Thus we see that all the studies show a consistent relationship between age and length of sentence. This means that the inferior achievement of the deaf in length of sentences may be taken as an indication of language retardation.

TABLE III

PERCENTAGE OF EACH TYPE OF SENTENCE USED BY DEAF AND HEARING CHILDREN, BY AGE GROUPS

Types of Sentence — Age	8	9	10	11	12	13	14	15	16	17
Hearing										
Simple	53	45	40	36	30	27	27			
Compound	31	36	38	38	41	42	43			
Complex	8	9	12	13	13	14	12			
Compound-Complex	8	10	10	12	15	17	18			
Total	100	100	100	99	99	100	100			
Deaf										
Simple				57	61	49	54	48	48	42
Compound				31	32	35	32	35	37	38
Complex				9	5	8	9	10	8	10
Compound-Complex				2	2	8	5	6	6	10
Total				99	100	100	100	99	99	100

V. FREQUENCY OF DIFFERENT TYPES OF SENTENCE

The next step in determining the difference in sentence structure between deaf and hearing children was to make a grammatical classification of the sentences according to structural type. We distinguish four classes: simple, compound, complex, and compound-complex. Table III and Figure 3 give the percentage of each type for deaf and hearing children by age groups. It will be seen (1) that simple and compound sentences make up the largest proportion for both deaf and hearing; (2) that the deaf use more simple than compound sentences at all age levels, while the hearing of the four highest age groups used more compound than simple sentences; (3) that simple sentences decrease and other kinds increase with age for both deaf and hearing children; (4) that the deaf use relatively more simple, fewer compound, complex, and compound-complex sentences than the hearing at all age levels. The smallest percentage of simple sentences used by the deaf (in the highest age group of seventeen

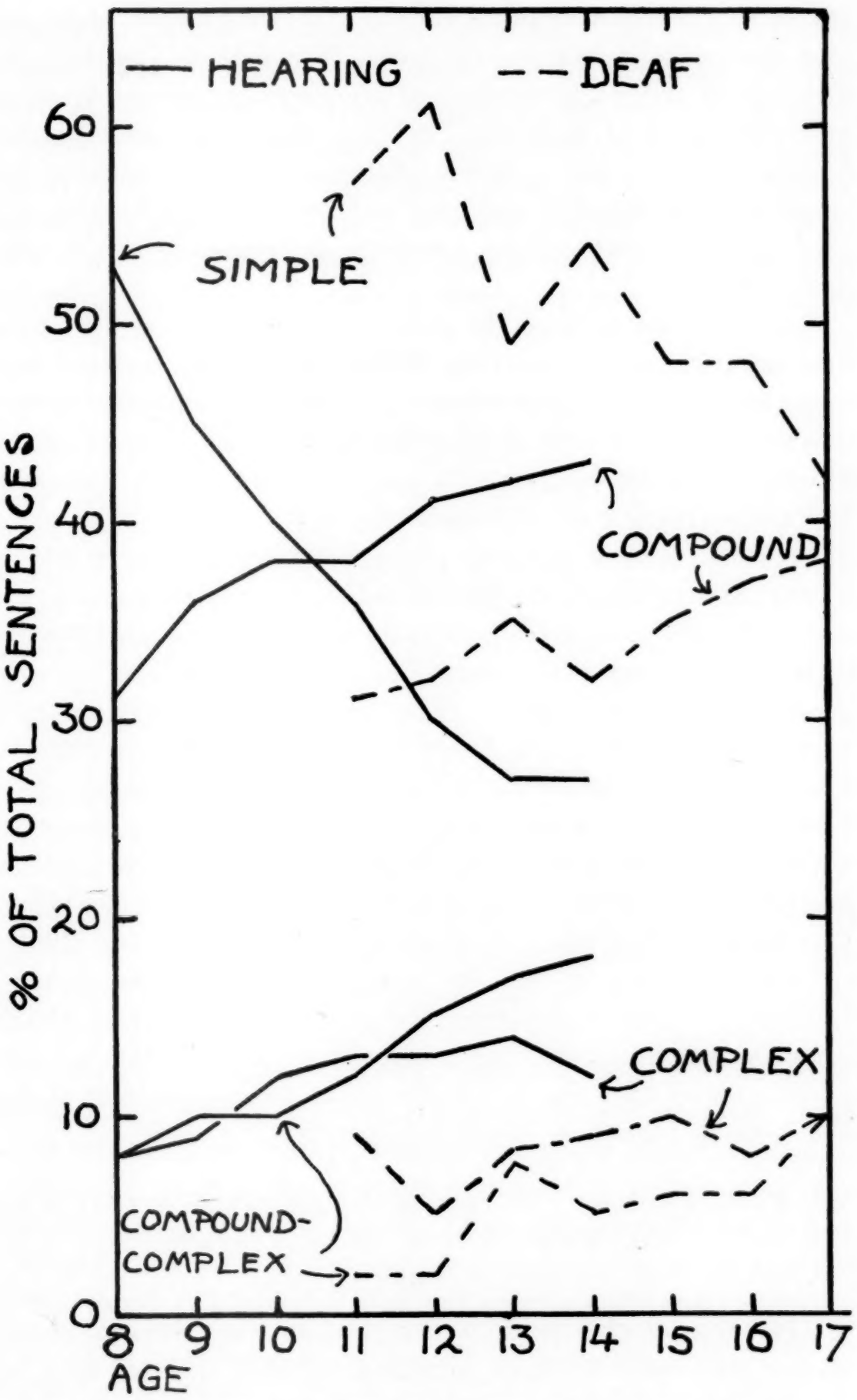

FIG. 3. Percentage of each type of sentence used by deaf and hearing children, by age groups.

years) is still higher than all but the first two groups (eight- and nine-year-old) of hearing children. Ten-year-old hearing children use as large a proportion of compound sentences as seventeen-year-old deaf children. All but eight- and nine-year-old hearing children use complex sentences more frequently than seventeen-year-old deaf children, and nine-year-old hearing children use compound-complex sentences as frequently as the oldest deaf children.

Thus, this analysis of the material repeats the results of our first comparison, that hearing children use larger sentence units than the deaf, and it goes beyond it in showing that this increase in length involved both development in the use of parataxis (the linking of clauses by means of *and* and *but*) and in the use of hypotaxis (the use of dependent clauses).

Previous studies confirm the developmental aspect of our results, although their results are not all directly comparable with ours. The different investigators do not all use the same sentence classification, and even when the classifications can be made parallel, the absolute values show the variations that are to be expected, since they are based on entirely different kinds of material. Nevertheless all the investigations of sentence classes (Davis, Boyd, Stormzand and O'Shea, and Hoppes) show consistently what we found, that the proportion of simple sentences decreases and that of all others increases in successive age groups. Our results differ from those of the other studies for children of the same ages in that the proportion of complex forms is smaller, but that is doubtless the result of the simple, clearly-organized material that we presented as a basis for the compositions and does not materially affect the comparison of deaf and hearing for whom it was held constant.

VI. Frequency of Finite Verbs Classified According to the Functions of the Clauses in which They Occur

The sentence classification according to the four grammatical classes gave only a rough grouping, since it did not take into

account the number of clauses in a sentence. The more elaborate classifications such as McCarthy's and Boyd's only partially corrected this defect. In our classification a sentence with two coördinate clauses was treated as equivalent to one with six, and one involving a single subordinate clause as one having several subordinate clauses. Further, it was impossible on the basis of such a classification to make a detailed study of the kinds of subordination involved, since a single sentence often included

TABLE IV

AVERAGE NUMBER OF FINITE VERBS PER SENTENCE; AVERAGE NUMBER OF WORDS PER FINITE VERB. DEAF AND HEARING BY AGE GROUPS

Hearing Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Ave. number of finite verbs per sentence	1.92	2.03	2.03	2.02	2.13	2.22	2.22				2.12
Ave. number of words per finite verb	5.2	5.3	5.4	5.4	6.2	6.1	6.2				5.7
Deaf											
Ave. number of finite verbs per sentence	1.50	1.58	1.75	1.62	1.79	1.71	1.90				1.72
Ave. number of words per finite verb	5.3	5.02	5.1	5.2	5.3	5.3	5.5				5.3

clauses used in different ways. Therefore we made a second analysis of the compositions, tabulating for each sentence the main verb [2]; the verbs in coördinate clauses with their connectives; the verbs in subordinate clauses with their connectives and the function of the clauses in which each was used; the infinitives, gerunds, and participles; and the prepositional phrases. This means that all clauses and phrases were included in the tabulation.

Table IV shows the average number of finite verbs per sentence and the average number of words per finite verb; that is, roughly, the average number of clauses per sentence and the average length of clause for deaf and hearing children of different

[2] In making this tabulation we followed the general procedure used by LaBrant for finite verbs.

age levels. In the number of clauses per sentence there is a small but fairly regular increase with age and a definite difference between deaf and hearing children. The oldest deaf children, on the average use about the same number of clauses per sentence as the eight-year-old hearing children. In length of clause the age development is still smaller, the deaf showing practically no increase with age, the hearing no increase for the first four, then a rise at twelve with no further gain. The deaf are equal throughout to the lower level of hearing children.

TABLE V

RATIOS: VERBS IN MAIN CLAUSES; VERBS IN COÖRDINATE CLAUSES; VERBS IN SUBORDINATE CLAUSES TO THE TOTAL NUMBER OF VERBS FOR DEAF AND HEARING CHILDREN OF DIFFERENT AGES

Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Verbs in Main Clauses	.53	.47	.49	.49	.47	.47	.46				.473
Verbs in Coörd. Clauses	.37	.41	.38	.36	.38	.38	.38				.376
Verbs in Sub. Clauses	.10	.12	.13	.15	.15	.17	.17				.149
Total	1.00	1.00	1.00	1.00	1.00	1.02	1.01				.998
Verbs in Main Clauses				.67	.66	.59	.64	.59	.58	.53	.595
Verbs in Coörd. Clauses				.26	.30	.32	.27	.30	.33	.35	.315
Verbs in Sub. Clauses				.07	.04	.09	.09	.11	.09	.12	.094
Total				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.004

Table V and Figure 4 show the proportions of verbs in each of the three main kinds of clause to the total number of finite verbs for deaf and hearing children of the different age groups; *i.e.*, the ratio of verbs used in main clauses, of verbs used in coördinate clauses, and of verbs used in subordinate clauses to the total number of finite verbs. These data show, with somewhat different emphasis, the differences shown by the sentence classification. Older children use relatively fewer verbs in main clauses than do younger ones, hearing children fewer than deaf. This class of course includes verbs in simple sentences, for which we have already seen that these relationships hold. Next in order of frequency to verbs in main clauses are verbs in coördinate clauses. Of these the hearing use relatively more than the deaf. The proportion shows little change with age for the

hearing, but for the deaf, to whom even this kind of increase in the size of the unit apparently represents an increase in difficulty, the coördinate clauses start at a somewhat lower level and show

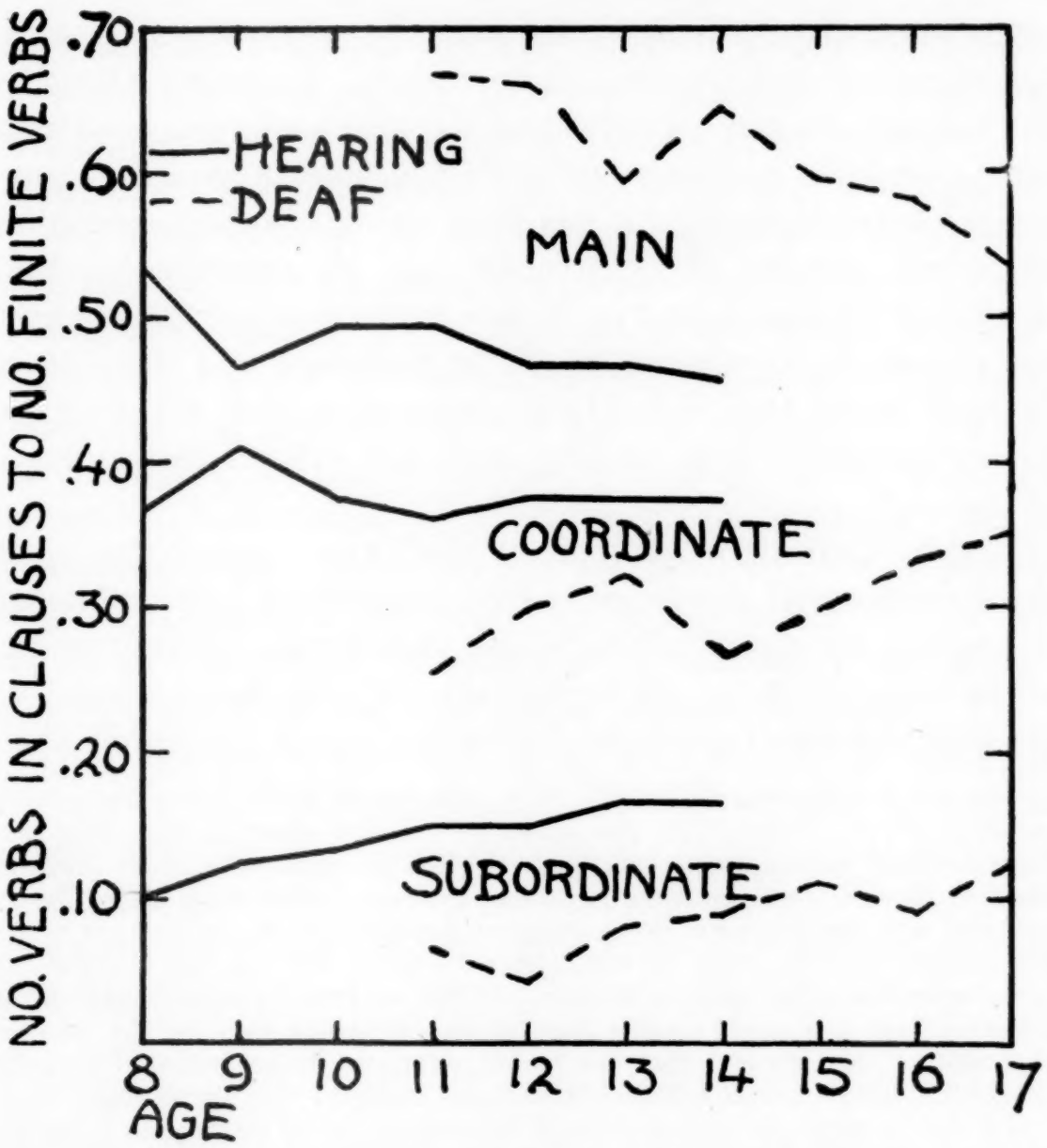

FIG. 4. Ratios: Verbs in main clauses; verbs in coördinate clauses; verbs in subordinate clauses; to the total number of finite verbs for deaf and hearing children, by age groups.

a rise with age that brings them almost to the level for the hearing. The subordination index (*Cf.* p. 6, note) rises with age for both deaf and hearing, but is higher for hearing than for deaf, only the seventeen-year-old deaf children reaching as high a level as the youngest groups of hearing children (the

eight- and nine-year-olds).[3] Our index for the hearing is lower than LaBrant's, which for the same ages ranges from .10 to .306. This difference is probably to be explained by differences in the subjects of the compositions used in the two studies. Our material consisted of simple narration in which the relation of the events to each other is clearly given. LaBrant, who gave her subjects the task of defending the long summer school vacation, must have secured material that included a greater proportion of argumentation. It has been shown that argumentation, as a rule, involves more frequent use of subordination than narration. Seegar found more than three times as many dependent clauses in argumentation as in narration and description. Wiswall found that 48% of the sentences used in his selections of argumentation were complex and only 33% of those used in narration.[4]

Besides LaBrant's there are several other studies that show the developmental significance of the subordinate index, although the results are not all given in the same terms. Davis reports an increase of .09 to .18 in the ratio of subordinate clauses to the total number of predicates [5] from the age of five and one-half

[3] Several investigators, Wiswall, Huth, Stormzand and O'Shea have called attention to the errors that are made in complex constructions and have suggested that complexity of expression is often the result of unclear thinking. They emphasize the importance of teaching simple, exact expression. Davis, however, who made a quantitative study of this problem in her analysis of the five longest remarks made by 436 children between the ages of 5½ and 9½ years, said that when the greater length of the sentence is taken into account, the error ratio is slightly smaller for the long sentences than for the material as a whole. She showed that the longer sentences in her material included relatively more subordinate clauses, also more infinitives than the average.

Her results make the assumptions of the writers quoted above, which are not based on quantitative data, seem doubtful. But in any case, the fact that children make errors in their approach to complex forms does not invalidate the developmental significance of those forms. All the data show that the use of complex forms is characteristic of adult language and of expression that involves finer shades of meaning, and we cannot escape the importance of the fact that deaf children use them less than hearing children.

[4] Wiswall did not consider these differences great enough to be important, but they clearly support the data of Seegar and it seems likely that if she had followed him in making a more exact analysis in terms of clauses, she would have found still greater differences.

[5] These figures are only from that part of her results obtained from boys who were singletons with siblings. It is not worth while for the purposes of our study to quote her results from other groups.

to nine and one-half years. She found significant differences between children of higher and lower socio-economic levels.

Stormzand and O'Shea found an increase from .24 in fourth grade to an adult average of .97 in the average number of dependent clauses per one hundred sentences, a ratio which shows the same differences although it is mathematically less exact than that which takes into account the total number of predicates.

Boyd does not give a single subordinate index, but his analysis of the different kinds of subordinate clauses used at different ages indicates that his material showed a subordination ratio of .142 at three years, of .30 at eight years, and of .375 for adults.

Deutzing found an increase in the average number of dependent clauses per one hundred sentences between the ages of eight and ten from 0.6 to 12.3.[6] Hoppes, like Boyd, gives no single measure of subordination, but his analysis of different kinds of subordinate clauses shows an increase from 49 to 61 dependent clauses per hundred sentences (for boys). Huth's study also shows an increase of subordination in successive age groups, although his groups are small and his results less regular.

These different measures of subordination, while depending as far as their absolute values are concerned on the kind of material or the situation involved, give definite indication of the close relation of subordination to age and support the results of our own comparison that the deaf are retarded in this aspect of their language development in comparison with hearing children.

VII. Infinitive Verbs

Table VI and Figure 5 show the relation of infinite to finite verb forms for deaf and hearing children at the different age levels. If we consider the data for all the infinite verb forms together, we see that on the whole older children, both deaf and

[6] His results show no further gain in the two succeeding age groups, and his actual figures are not comparable to those of other studies. He used descriptions of single pictures for his material and obtained a very high percentage of simple sentences: 78% at fourteen years. Sample descriptions show that they involved considerable cataloguing of content rather than a single unified account such as we obtained from our motion picture material and others obtained in more usual language situations.

hearing, use a higher percentage of infinite verb forms than younger ones. The differences between deaf and hearing are somewhat smaller than in the other comparisons. For the lower age groups the differences range from one to three years and are therefore smaller than the average language retardation of the deaf. For the upper age groups they are greater.

TABLE VI

RATIOS OF TOTAL INFINITE VERB FORMS; OF PARTICIPLES; OF GERUNDS TO TOTAL FINITE VERBS FOR DEAF AND HEARING CHILDREN OF DIFFERENT AGES

Ages	8	9	10	11	12	13	14	15	16	17	Total
Total infinite verb forms	.07	.073	.075	.098	.13	.147	.14				.114
Infinitives	.053	.052	.053	.056	.07	.074	.065				.06
Participles	.013	.015	.018	.033	.046	.061	.054				.04
Gerunds	.004	.006	.004	.009	.014	.012	.021				.014
Total infinite verb forms				.073	.077	.101	.102	.111	.101	.127	.104
Infinitives				.053	.048	.063	.067	.073	.073	.094	.072
Participles				.015	.024	.029	.03	.031	.021	.026	.026
Gerunds				.005	.005	.009	.005	.007	.007	.007	.006

When we consider the ratios for infinitives, participles, and gerunds separately, we see that on the whole the separate curves rise with age as the general curve did, although the ratios for the upper age groups are irregular. The main difference is that the hearing use more participles in the higher age groups, while the deaf show a sharp rise in the curve for infinitives. This curve rises in the end to a point considerably above the highest point of the curve for the hearing.

VIII. PREPOSITIONAL PHRASES

Table VII shows the number of prepositional phrases per finite verb for the different age groups of deaf and hearing children. In this case we find that there is an increase in successive age groups, although not an altogether regular one. For the four parallel age groups deaf and hearing are approximately equal, and the curve continues to rise for the higher age groups of the deaf. We may therefore say that the deaf are apparently more advanced in the use of this language form than in their language

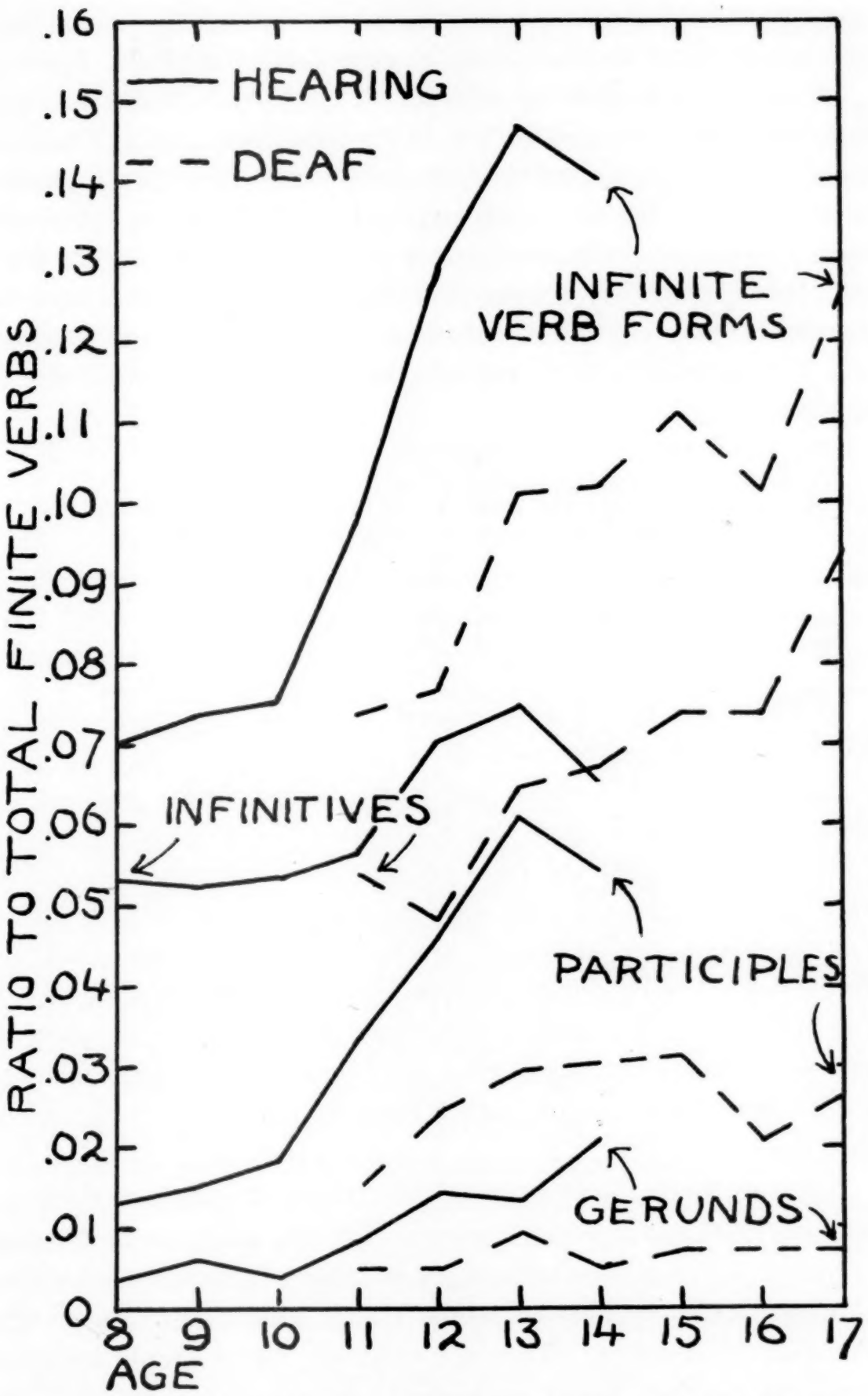

FIG. 5. Ratios of total infinite verb forms; of infinitives; of participles; of gerunds to total finite verbs for deaf and hearing children of different ages.

development as a whole, since we know that on the whole they are retarded by several years in comparison with the hearing.

Thus the deaf show no retardation in the use of the infinitive and are even advanced in the use of the prepositional phrase. This does not mean probably that they are superior in the use of these forms, but that higher age groups which begin to express more complicated relationships use phrases to express what could also be expressed by subordinate clauses. As we shall see, the deaf use relatively fewer subordinate clauses than the hearing, and it seems likely that some of them are replaced by phrases in this way.

TABLE VII

RATIOS: PREPOSITIONAL PHRASES TO FINITE VERBS FOR DEAF AND HEARING CHILDREN OF DIFFERENT AGE GROUPS

Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Hearing	.32	.32	.35	.34	.43	.44	.43				.39
Deaf				.41	.40	.43	.41	.45	.50	.46	.45

We have not found other studies that show development in the use of prepositional phrases or of infinite verb forms, only individual analyses that show that these forms appear later in the speech of children than the elements of the simple sentence. LaBrant found that the ratio of infinitives to verbs in subordinate clauses decreased with age, but this gives no definite information about the infinitive itself, since we know that the frequency of subordinate clauses increased rapidly with age in her material. This comparison would have still less meaning in our study since the deaf, who used fewer subordinate clauses, would have shown a still higher ratio of infinitives computed on this basis.

To summarize these grosser differences in sentence structure between deaf and hearing children: The compositions of the deaf are made up of a relatively larger number of sentences which are shorter both in number of words and in number of clauses than those of the hearing. They use relatively more simple sentences than the hearing, fewer compound and complex sentences. An

analysis in terms of single verbs shows similarly that the percentage of verbs in main clauses is higher, of verbs in subordinate and coördinate clauses lower than for the hearing.

There is no great difference between deaf and hearing in average length of composition and in length of clause. In all the comparisons that we made, with the exception of the comparisons of the infinitive and prepositional phrase, differences between deaf and hearing children were in the same direction as differences between younger and older children, the performance of the deaf resembling that of younger hearing children.

IX. Kinds of Subordinate Clauses Used by Deaf and Hearing Children of Different Ages

In continuing our analysis of subordinate clauses we first followed LaBrant in using the standard grammatical classification (*Cf.* Smart, 29, 112–119) which distinguishes three main types of clause—noun, adjective, and adverbial, with sub-groups under each. It proved to be more complicated in some cases than our material required; in others it grouped together forms which were distinct in our material and which we found it better to treat separately. Thus time and place clauses were each listed twice, once as adjective clauses and once as adverbial clauses, a distinction which was quite irrelevant for our study [7] and which would only have made the handling of the results more complicated. At the same time three kinds of noun clauses used in different ways in our material (those introduced by *that,* those introduced by *if,* and the interrogative in indirect discourse) were all grouped as "noun clauses used as the objects of verbs."

For our comparison of deaf and hearing children it was more important to have a classification that covered our own material adequately than to be able to follow closely the results of previous studies. Therefore we finally abandoned the standard classification in favor of a simpler one of seven groups which included the major forms used in our compositions, altogether 95% of

[7] LaBrant also found this duplication difficult to handle and finally omitted from her analysis the few time and place clauses used as adjectives.

all the subordinate clauses.[8] These seven forms are as follows: clauses of time, of place, causal clauses, relative clauses, object clauses introduced by *that* (either explicitly stated or implied), object clauses introduced by *if* (and in a few cases *whether*), and the interrogative in indirect discourse. The remaining five per cent included twenty-four different forms, too few of each to be handled separately in the comparison of deaf and hearing children.

TABLE VIII

NUMBER OF VERBS IN EACH KIND OF SUBORDINATE CLAUSE PER 1,000 FINITE VERBS: DEAF AND HEARING CHILDREN, BY AGE GROUPS

Kinds of Clause	Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Hearing												
Time		45.2	44.0	53.2	67.0	55.2	63.1	60.8				57.0
Obj. (that)		18.9	26.3	24.7	26.2	30.3	33.9	35.6				29.1
Obj. (if)		18.9	22.0	19.9	18.8	22.2	15.0	16.5				18.5
Rel.		8.2	9.0	12.6	16.7	21.2	21.9	25.2				18.0
Obj. (int.)		4.4	6.7	6.5	9.4	10.9	13.3	8.7				9.5
Place		1.9	3.5	4.5	4.5	4.0	6.8	4.7				4.65
Cause		3.1	1.2	2.4	2.4	3.6	3.9	4.4				3.16
Others		2.5	3.1	5.7	7.2	6.9	12.5	14.1				8.4
Deaf												
Time					5.62	2.8	10.5	10.4	13.7	12.5	12.4	10.9
Obj. (that)					33.7	24.9	40.3	52.8	45.7	42.1	49.0	44.5
Obj. (if)					9.8	8.3	10.5	6.7	13.7	9.2	10.5	10.0
Ref.					1.4	..	3.5	3.0	8.6	5.3	10.0	5.7
Obj. (int.)					5.62	1.4	8.8	9.7	11.4	10.5	14.7	10.0
Place					..	..	.88	..	2.3	3.9	4.3	2.13
Cause					5.62	1.4	5.26	6.7	4.6	4.6	10.5	6.15
Others					0.0	1.4	4.4	3.0	6.9	2.6	5.7	4.1

Table VIII gives the number of each of these classes per 1,000 finite verbs for deaf and hearing children of different ages. Figures 6 and 7 show the ratios graphically. We see, as we would expect from the subordination ratios, that most of the curves rise with age. Older children use more of almost all kinds of subordinate clauses than younger ones. The only exception is the object clause with *if*, which decreases irregularly with age for the hearing and shows no significant gain for the deaf.

[8] This classification is in agreement with the suggestion of Salisbury (27) who said, "Whether a clause is adverbial or adjectival is not a front seat question. Whether it tells *and* or *when*, *but* or *unless*, *as* or *so* is of greater importance."

Differences between deaf and hearing are in some cases still more striking than the differences of the subordination indices, since there are two cases in which the general direction of difference is reversed and one in which there is no significant difference.

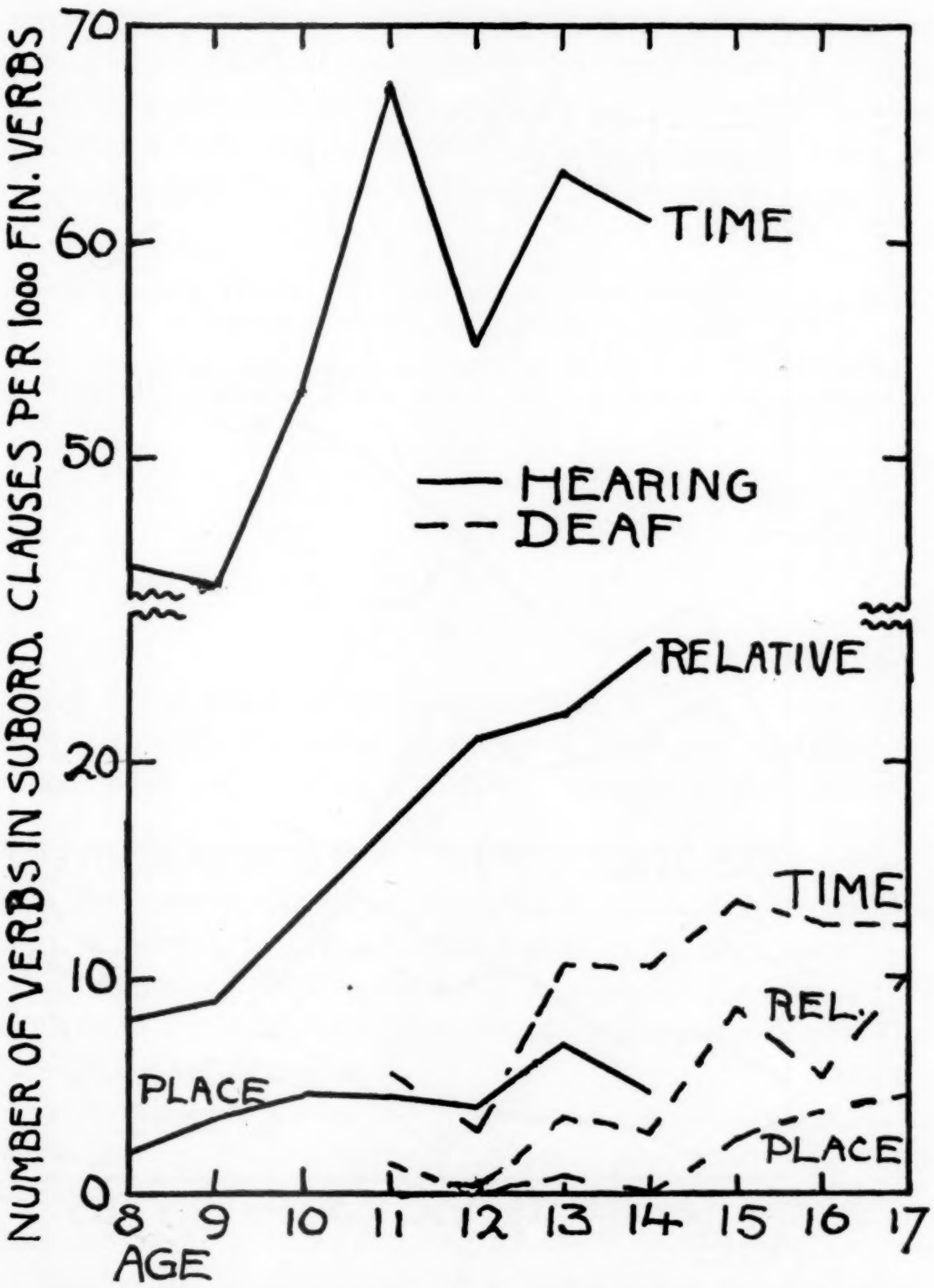

FIG. 6. Number of verbs in each kind of subordinate clause per 1,000 finite verbs: Deaf and hearing children, by age groups.

The deaf use relatively more of the object clause with *that* and the causal clause than do hearing children, and are approximately equal to hearing in the use of the interrogative in indirect discourse. That means that the differences in the subordination

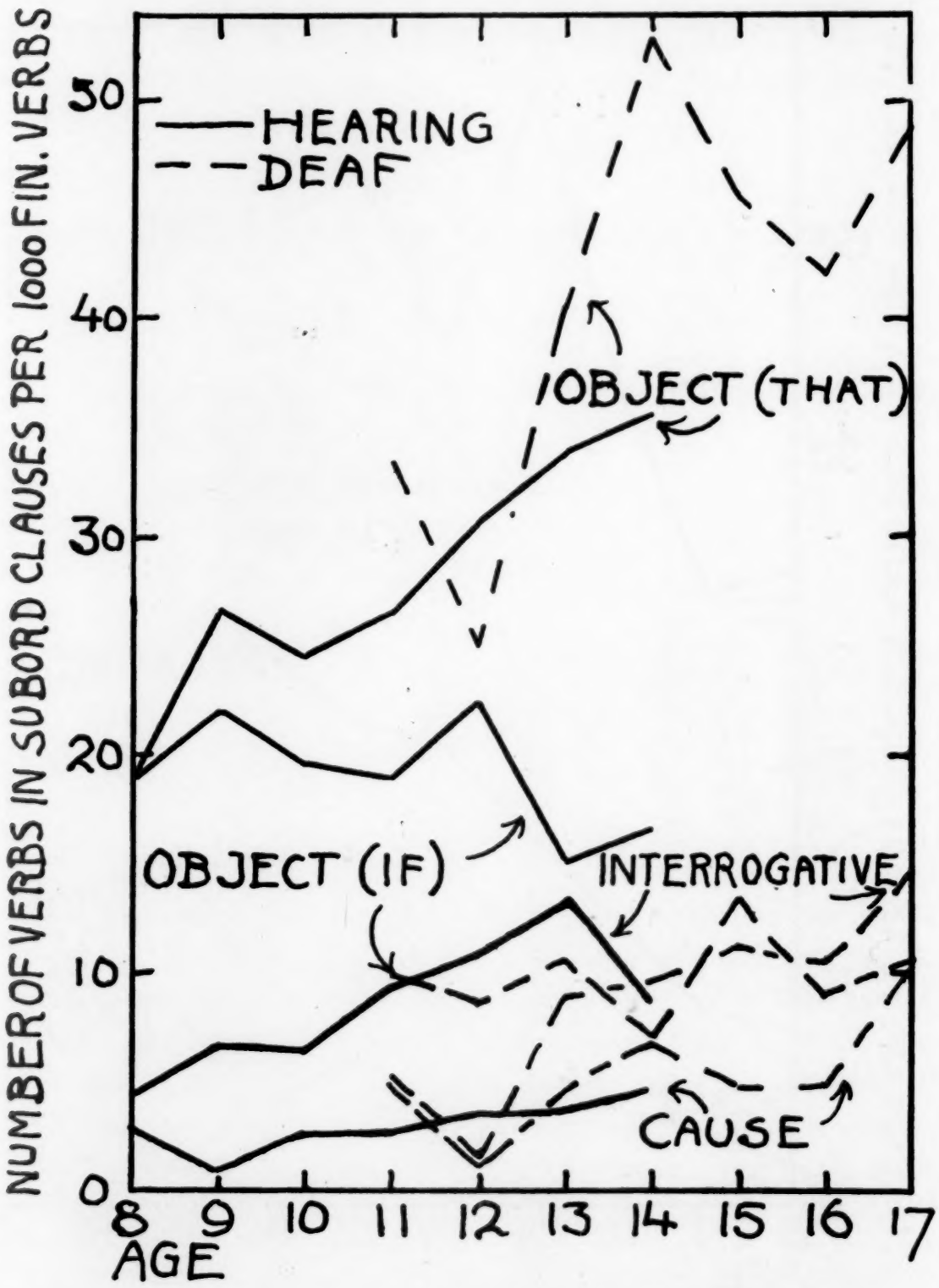

FIG. 7. Number of verbs in each kind of subordinate clause per 1,000 finite verbs: Deaf and hearing children, by age groups.

ratio are the result of differences in the frequency with which the remaining four kinds of subordination are used. The most important single case is that of the temporal clause. For hearing children it is the form most frequently used, occurring twice as often as the object clause with *that,* which is second in rank. For the deaf it falls into a group of much lower rank. Of the cases in which the deaf are superior the causal clause is among the less frequent for both deaf and hearing, but the case of the object clause with *that* is especially important since it is one of the major groups for both deaf and hearing children.

TABLE IX

RATIOS SHOWING DIFFERENCES BETWEEN DEAF AND HEARING IN THE USE OF DIFFERENT KINDS OF SUBORDINATE CLAUSES

(Positive values represent cases in which a form is more frequently used by the Hearing; negative values cases in which a form is more frequently used by the Deaf.)

Time	+.68
Relative	+.47
Place	+.37
Others	+.34
Obj. (if)	+.29
Obj. (int.)	—.025
Obj. (that)	—.209
Cause	—.22

Table IX is based on the data of Table VIII. The kinds of clause are arranged in order according to the degree of difference between deaf and hearing, the values expressing the difference being computed according to the formula: $\frac{H-D}{H+D}$. The cases in which the hearing are superior are thus represented by positive values, those in which the deaf are superior by negative values. These differences between deaf and hearing in the use of different kinds of subordinate clause will be discussed in detail in section XI, page 87.

There are several other studies of the relative frequency of different kinds of subordination. Most of them follow the kind of classification presented by Smart and treat noun and adjective clauses as single groups, dividing adverbial clauses further into the functional sub-groups of time, place, purpose, etc. This classification does not correspond exactly to ours, but can be used

as the basis for a rough comparison of our results with theirs. Thus the adjective clause is made up almost entirely of relative clauses, clauses of place and time being so few that they can be disregarded for most purposes. Noun clauses are usually objects of verbs. LaBrant found that 114 out of a sampling of 133, 85%, were used as objects of verbs. Stormzand and O'Shea report that 74% of their noun clauses were used in this way. Noun clauses in these studies may therefore be compared with our three groups of object clauses taken together. Since most clauses of time and place are adverbial, we can compare our values for all the causes that fall into these functional groups with values in other studies for adverbial clauses of time and place. Causal clauses occur only in the adverbial form, hence present no difficulties for comparison.

On the basis of these groupings we will first compare the relative frequencies of each of the three main types of clause (noun, adjective, and adverbial) in our compositions with those of other studies. In order to do this we must first re-state the results presented in Table VIII. Most of the other studies give the ratio of verbs in each kind of subordinate clause, not to the total number of finite verbs as we did in Table VIII, but to the number of verbs in dependent clauses. This ratio seemed to us to tell less than the other about the frequency with which a given form actually occurs in a composition of given length. Therefore we do not use it in discussing our own results, but present it at this point for comparison with other studies. Table X gives the ratio of each of our seven kinds of subordinate clauses to the total number of verbs in subordinate clauses.

Table XI shows these ratios, grouped roughly as the ratios for verbs in noun, adjective, and adverbial clauses, in comparison with ratios for these main groups in the material of LaBrant and Stormzand and O'Shea. This table shows that our results for both deaf and hearing differ from the others in having a higher percentage of noun clauses (this in spite of the fact that our classification includes only noun clauses used as objects and therefore probably omits a few) and fewer adjective clauses. This relatively greater frequency of noun clauses in our material is

probably a result of the content of our story which involved a good deal of conversation that was written as indirect discourse. For the hearing, as in the other studies, adverbial clauses make up the largest single group. The results for the deaf differ from those obtained by other studies, as well as from our own results for hearing children, in having a much higher percentage of noun than of adverbial clauses.

TABLE X

RATIO, IN PER CENT, OF THE NUMBER OF VERBS IN EACH KIND OF SUBORDINATE CLAUSE TO THE TOTAL NUMBER OF VERBS IN SUBORDINATE CLAUSES FOR DEAF AND HEARING CHILDREN OF DIFFERENT AGES

Kinds of Clause / Ages	8	9	10	11	12	13	14	15	16	17	Average Total
Hearing											
Time	.44	.38	.41	.44	.41	.37	.36				.38
Obj. (that)	.18	.23	.19	.17	.20	.20	.21				.20
Obj. (if)	.18	.19	.15	.12	.14	.09	.09				.13
Rel.	.08	.08	.10	.11	.14	.13	.15				.12
Obj. (interr.)	.04	.06	.05	.06	.07	.08	.05				.06
Place	.02	.03	.03	.03	.03	.04	.03				.03
Cause	.03	.01	.02	.02	.02	.02	.03				.02
Others	.02	.03	.04	.05	.05	.07	.08				.06
Deaf											
Time			.075	.07	.13	.11	.11	.14	.11		.12
Obj. (that)			.59	.62	.48	.57	.42	.44	.42		.48
Obj. (if)			.17	.21	.13	.07	.11	.10	.09		.11
Rel.			.02	..	.04	.03	.08	.06	.09		.06
Obj. (interr.)			.08	.03	.10	.10	.11	.12	.13		.11
Place			..	..	.01	..	.02	.04	.04		.02
Cause			.08	.03	.06	.08	.04	.05	.09		.07
Others			..	.03	.05	.03	.06	.03	.05		.04

TABLE XI

RATIOS OF VERBS IN EACH OF THE THREE MAIN KINDS OF SUBORDINATE CLAUSES TO THE TOTAL NUMBER OF VERBS USED IN SUBORDINATE CLAUSES

Results of this study compared with those of studies by LaBrant and Stormzand and O'Shea.

Kind of Clause		Noun	Adj.	Adv.
This study	Hearing	.39	.12	.49
	Deaf	.69	.06	.24
Stormzand and O'Shea *		.27	.29	.45
LaBrant		.24	.21	.55

* 4th grade—High School.

Hoppes, whose figures are not given in Table XI, since he computed his ratio in terms of the total number of sentences rather than of the total number of clauses, also found that adverbial clauses made up his largest group (.31–.33) with noun clauses second (.13–.19) and adjective clauses third (.058–.098). Boyd, who based his ratio for the years three to eight on the number of main clauses, also found adverbs the largest group (.06–.137), noun clauses second (.48–.125) and adjectives the smallest (.028–.038). Thus we see (1) that our results for hearing children, as far as our rough comparison of the three main grammatical classes of dependent clauses is concerned, follow those of other studies; (2) that there is a marked difference between the data from the hearing in all these studies and those from the deaf children in our own.

Comparing the results of other work as to the frequency of single kinds of adverbial clauses we find, corroborating our own results from hearing children, that time clauses are of special importance. In LaBrant's work they were more frequent than all the noun clauses, or all the adjective clauses taken together and were more than twice as frequent as any other kind of adverbial clause. Stormzand and O'Shea found them the most frequent of all dependent clauses. Seegars found them second only to the substantives in indirect discourse (therefore to the major part of the group of noun clauses) in narration and description. In argumentation in which causal clauses were most frequent they still occupied an important place. Considering the close agreement as to the relative frequency of temporal clauses in these three studies and in our own results from hearing children based on entirely different kinds of material, it seems fair to assume that the temporal clause ordinarily plays an important part in the compositions of hearing children and that the striking difference between deaf and hearing in our results is a significant one.

It is more difficult to compare our results in regard to causal clauses with those of other studies since, as we have seen, that construction is especially easily influenced by the subject of the

composition. Seegars showed that it increased with the introduction of argumentation and since we know that LaBrant's material at least must have contained a fairly high proportion of argumentation, it is not worth while to make a direct comparison with the results of other studies for that construction. Place clauses are relatively infrequent in all studies and are therefore not considered here.

X. Analysis of Differences Between Kinds of Subordinate Clauses

Our first analyses showed differences between deaf and hearing children that corresponded on the whole to differences between younger and older children. Further, they showed that the same differences could be traced in studies of language development from the earliest stages, and could in general be described in terms of relative difficulty. An inspection of Figure 9 shows that this is not the case for all forms within the group of subordinate clauses. For the hearing all except one, the object clause with *if,* follow the general curve of the subordination index; that is, they are used relatively more by older than by younger children. Yet two of them are used more frequently by deaf than by hearing: the object clause with *that* and the causal clause.

Our first problem is to study the seven groups of dependent clauses that were important in our material and try to find out whether there are differences between them in structure and in the relationships that they express which will explain the differences between their use by deaf and by hearing children. In studying these differences we will have to explain why, in frequency of use of subordinate forms, deaf children did not consistently resemble younger and less mature hearing children as they did in most of the preceding comparisons.

The only studies of language which attempt the kind of analysis that we must make are the monograph on the language of young children by Clara and William Stern and William Stern's treatment of the results of the Minkus test with school children.

These do not bear directly on our results, even aside from the fact that they were made in another language,[9] but they suggest the kind of factors that we must look for in our comparison. For example, in his analysis of the results of the Minkus test Stern showed that the question of temporal sequence of the two clauses and also the relationship of their content were important. The difficulty of causal constructions in which the temporal sequence of the sentence was interrupted was greater than that of cases in which it proceeded directly. He also found that cases in which the second thought disappoints the expectation of the first or completely displaces it, involved special difficulty. In each case he discussed the developmental significance of a given form, *i.e.,* whether it appeared early or late in individual development and whether it is in common usage in the language.

In studying our own material we began with a consideration of the gross differences in style which are to be noticed in reading the compositions. We worked out a series of factors corresponding to these differences and analyzed the seven kinds of subordinate clauses in terms of these factors and factors suggested by other studies to see whether differences existed between them that could be expressed quantitatively and related to our previous analyses. The main differences of style which we considered were: (1) The paragraphs of the deaf were less unified than those of the hearing. Our data have already shown that they were made up of a relatively larger number of units. In reading the compositions over, one feels that they are built up more by a

[9] Stern's comparison included frequently-used and less common connectives and he tried to discover the differences between them. The very simplicity of our material was such that only the most common connectives of each functional category were used to any great extent. Our major comparisons were thus between causal clauses of the most elementary kind and temporal clauses of the most elementary kind, not between more and less common ways of expressing the different relationships. The nature of Stern's method introduced another factor of difficulty, which, as far as our results go, was a purely artificial one. He showed that in some cases a connective which in its developmental history and its form seemed especially simple was relatively difficult in the completion test. This, he showed, was because these forms were not absolutely essential to the meaning and were therefore supplied only by a few subjects who had a feeling for finer distinctions of language.

process of juxtaposition, while those of the hearing show greater overlapping of units. (2) They included more fixed phrases that could be learned and used as units. (3) They used less variety of expression. In evaluating these differences we considered the following points:

1. Is the word order of the subordinate clause that of the corresponding simple form? This question asks not only whether the words of the subordinate clause could stand alone as simple sentences, but if they did, whether they would carry the same meaning that they did in the larger whole. The following examples illustrate the meaning of the question: "He was hungry" is the simple form that corresponds to the subordinate clause of the sentence: "He said that he was hungry." There is no change of word order.

But in the case of, "He went to see if his mother was there," the meaning of the clause is a question and the corresponding simple sentence would take the interrogative form: "Is (or was) his mother there?" with a change of word order.

2. Does the subordinate clause usually precede, follow or interrupt the action of the main clause? This point is probably very important for the process of constructing a sentence. When the subordinate clause comes before or interrupts the action of the main clause, a statement is made whose whole meaning is not fully determined until something else is said. It must be held in abeyance until the main clause is completed. This means that it is necessary that the whole exist, at least implicitly, from the beginning. Examples are: "*When the boy's mother found him* she saw that he was sick," or, "*The boy who ran up on the porch* was hungry."

But when the subordinate clause follows the main clause it is always possible at least for the sentence to have been built up by a simple process of accretion as it was spoken (or written). An example of this kind is: "The boy asked his mother for a banana *because he was hungry.*"

3. Do differences of meaning require a choice between con-

nectives? The causal clause, for example, was almost always introduced by the connective *because* in the cases that we are comparing. In a few sentences *for* was used instead, but not in such a way as to involve a difference of meaning. Temporal clauses, on the other hand, were introduced by a series of different connectives differing in the nature of the time index which they gave to the main clause.

4. Does the content express actuality or what is only possible? This difference is exemplified by the two forms: " He said that he was hungry," and, " His mother asked him if he was hungry."

5. Is either main or subordinate clause incomplete in the sense that it could not stand alone as a simple sentence (if the connective were omitted, or in the case of the relative, if the antecedent were substituted for the pronoun)? The sentences with object clauses are clear cases in which the main clause could not stand alone. " He said (that)," or, " He went to see (if)," does not make a grammatically complete sentence. The sentence is unfinished and calls for a completion of a particular sort.

In the construction with a place clause on the other hand, we have a case in which the main clause is an independent unit but the subordinate clause which comes at the end could not stand alone. The clause " he was " of the sentence, " His mother came out to see where he was, " leave us waiting for at least one more word. That the incomplete clause comes last, gives the whole a strong unity, since the subordinate clause becomes complete by pointing back to what has come before. The main clause must remain in an active state to serve the needs of the subordinate clause which is to come. This is very different from the sentence with the object clause. In that case the incomplete form comes first, and the completion is made by means of a self-contained clause, with direct progress from one part to the next. In the other case the movement is circular.

6. Does the subordinate clause affect the meaning of a single word of the main clause or of the clause as a whole? The meaning of this question can be illustrated by a comparison of the

sentences: "The boy who ran up on the porch was hungry," and, "He sat on the porch while he ate the banana." Grammatically speaking, the subordinate clause in each of these examples is described as modifying a single word, in the first a noun, in the second a verb, but as far as the meaning is concerned there is a real difference between the two in their relation to the main clause. The relative clause follows the word that it modifies, and explains or limits its meaning. The temporal clause, as far as its effect on the sentence goes, does not belong strictly to the one word *sat*; rather, it gives a time index to the whole action: *he sat on the porch.*

Of the six points which we consider in this analysis the first four represent differences which can definitely be spoken of in terms of relative difficulty. The construction in which the subordinate clause follows the word order of the simple form expressing the same meaning is easier to handle than one in which the word order changes. The importance of the relative position of main and subordinate clause is obvious. To begin a sentence with a subordinate clause whose meaning must be held incomplete until the main clause is given is more difficult than to make a definite statement which is afterwards qualified or modified by a clause. Stern's psychological analysis of connectives showed the importance of this factor. Cole (5) in discussing sentence structure from the point of view of the teacher says, "It takes more foresight than most children possess to place a subordinate clause first in a sentence."

Stern's study, as well as the more general psychological studies of language (*Cf.* Goldstein, 11, and Piaget, 23) have shown the importance of the difference between the concrete statements of fact and more abstract statements of possibility as represented by our fourth point. Piaget points out that there is a development of the notion of possibility that is important for formal reasoning (23, p. 244 ff.), and Goldstein finds the distinction between concrete and abstract levels of thought a fundamental one for his whole discussion of the psychological results of brain lesion.

It is not possible to determine in advance the relative difficulty of the alternative of the fifth question, whether either clause is incomplete in the sense that it could not stand alone as a simple sentence, as regards the main clause. There seems to be no reason why the incompleteness of the main clause, as exemplified by the object construction, should involve special difficulty. The two parts of the sentence are structurally more closely united than are, for example, the parts of a sentence with a causal clause, but probably not in such a way as to complicate the process of formulation. It may even be that the extent to which the main clause calls for and prescribes the form of the subordinate clause makes the construction a stereotyped one that is relatively easy to use.

But the case in which the incomplete subordinate clause follows and must refer back to the main clause for its own completion is a different one. This form, like the one which a subordinate clause precedes and must wait for its full meaning until the main clause is spoken, is one in which the sentence must be active as a whole and probably involves the some psychological difficulties of formulation.

Our sixth question, whether the subordinate clause belongs to the main clause as a whole or whether it definitely modifies the meaning of a single word, also presents alternatives that we cannot describe in terms of relative difficulty. Two of the forms which hearing children use relatively more than deaf (relative clauses and clauses of place) and which according to other criteria are relatively difficult (*cf.* pp. 83f.) belong to the group in which the clause modifies the meaning of single words, but this is no proof that this factor in itself involves a difference of difficulty. One might suggest that a clause which modifies a single word is used with greater precision and requires greater control of language forms than one which is attached to a clause as a whole, but our material is not sufficient to prove that this is so.

Following is a discussion of each of the major forms of subordinate clause in terms of these six points. Table XII summarizes the results of this analysis.

Sentences with causal clauses: Examples of characteristic causal constructions from our material are:[10]

The boy wanted a banana *because* he was hungry.
His mother refused *because* she was afraid he would get sick.
He rubbed his stomach *because* he had a pain.
She gave him oil *because* he was sick.
He was sick *because* he had eaten too many bananas.

According to each of the points of our analysis the causal clause proves to be a relatively simple form. The word order is that of the corresponding simple sentence and it always comes after the main clause. While the meaning of the subordinate clause amplifies the statement of the main clause it does so as a simple addition to it, something that could almost as well have been expressed as a separate sentence. The relationship does not involve shades of meaning that require a choice of connectives. The content expresses a definite actuality.

TABLE XII

ANALYSIS OF THE SEVEN MAJOR KINDS OF SUBORDINATE CLAUSES IN TERMS OF FACTORS AFFECTING STYLE OF COMPOSITION

	Cause	That	Interr.	If	Place	Rel.	Time
Word order of subordinate clause like that of corresponding simple form: X; different: O.....	X	X	X or O	O	X	X	X
Subordinate clause follows main clause: X; interrupts or precedes: O.....	X	X	X	X	X	X or O	O
No choice between connectives based on differences of meaning: X; choice: O.....	X	X	O	X	X	O	O
Content expresses actuality: X; possibility: O.....	X	X	X	O	X	X	X
Both clauses are able to stand alone as simple sentences: X; one unable: O.....	X	O	O	O	O	X	X
Subordinate clause belongs to the main clause as a whole: X; it modifies some particular word: O	X	X	X	X	O	O	X

[10] The examples that we quote always represent the most characteristic uses of the form under consideration and usually occur both in compositions of deaf and in those of hearing children.

We do not quote the same number of examples for each kind of subordination, since some forms are used in more different ways than others. We try, for each, to give a fair sample of the way in which that form was used in telling the story that we are studying.

Structurally it is made up of two parts both of which could stand alone as independent sentences. The subordinate clause modifies the meaning of the main clause as a whole.

Thus we see that this form, which deaf children use most frequently in comparison with hearing children, is one which involves none of the factors that according to our analysis make for special difficulty. Of all the forms used in our material its structure is most like the juxtaposition of two simple sentences.

Sentences with object clauses: We will first consider the three different kinds of object clause together: (1) the object clause introduced by *that* (whether actually used or implied); (2) the interrogative in indirect discourse; (3) the object clause introduced by *if* (or occasionally *whether*). Examples of the most frequent uses made of these clauses in our material are the following:

That:	His mother said *that* he could have a banana. She saw *that* he was sick. He thought he wanted another.
Interrogative:	The mother asked *what* the boy wanted. She came to see *what* was the matter with him. She looked to see *who* was knocking. She came to see *where* her boy was.
If:	He looked to see *if* his mother was in the room. He asked *if* he could have a banana. He looked to see *whether* his mother was there.

The three groups differ in the extent to which the word order is like that of the corresponding simple form. The object clause with *that* involves no change of word order. The simple sentence "He could have a banana," and the subordinate clause of the complex sentence "His mother said that he could have a banana," express the same meaning without change. In most cases the interrogative employs the word order of the simple form in the complex sentence; for example: "She looked out to see who was knocking," and, "Who was knocking?" There are, however, a few cases in which the form of the verb would have to be changed to make a correct question. For example: "The mother asked what the boy wanted." In this case the simple question would require the verb form *did want* or *does want* following the inter-

rogative pronouns. But as we have seen, *the object clause introduced by if* regularly requires a change of word order to express the same meaning in a simple sentence.

In all three forms of object clause the position of the subordinate clause is constant, always coming at the end of the sentence. The first form uses only the one connective *that,* the third the one connective *if,* or occasionally *whether,* but in such a way that no choice of meaning is involved. The interrogative on the other hand may be introduced by any one of three introductory words: *who, what,* or *where.*

The three kinds of clause differ also as to whether the relationship is expressed in terms of actuality or possibility. The *object clause introduced by that* is the final statement of a concrete fact. The interrogative involves a question, but one which is based on a certain amount of knowledge. "She went to see who was knocking" tells you definitely that someone was knocking. The purpose of the question is to obtain a more definite determination of what is already known, and nothing is said that could be negated by the answer which is expected. The third form, for example, "He looked to see if his mother was there," expresses something that is only a possibility.

Of the seven kinds of subordination which occurred with sufficient frequency in our material to be used for purposes of comparison, the three forms of object clauses are the only ones for which this recognized distinction between actuality or possibility of content seems important. An examination of our material indicates, however, that it may account to a large extent for the fact that the *if* clause is used less frequently by deaf than by hearing children, although the other kinds which follow the same structural pattern are used as frequently or more frequently by the deaf.

The object construction is one in which the main clause is always grammatically incomplete, the subordinate clause practically always one that could stand alone as a simple sentence. Of all the constructions which we consider, this one follows most closely the basic form of the simple sentence: subject-verb-object, the object in most cases being essential to the construction, since

the verb is almost always a transitive one (except in the case of "to think").

While the subordinate clause is grammatically the object of the verb, it belongs in its meaning to the sentence as a whole and cannot be said to limit the meaning of a single word within the sentence.

Thus we see that the object clauses as a group are relatively simple structures. The complex sentence with the clause introduced by *that* differs from the sentence with a causal clause, according to our analysis, only in that one of its clauses is grammatically not a complete unit. The two are used with almost equal relative frequency by the deaf. The interrogative in indirect discourse differs from the *object clause with that* in that its use requires a choice between connectives, and we see that its position on our scale of relative frequency for deaf and hearing children is quite different from that of the two preceding forms. It is used approximately equal frequency by the two groups of children. The *object clause with if* differs from the other kinds of object clauses in its content, that is in the nature of the conceptual relationship which it expresses, and is used less often by deaf than by hearing children.

Sentences with clauses of place: Clauses of place, even in our material in which changes of position are important for the action of the story, make up a very small proportion of the total number of subordinate clauses. Examples of the cases in which they were used most frequently are:

Adjective clauses:	He knocked on the window *where* his mother was.
Noun clauses:	He went back to *where* he had been sitting.
	(Also: She went out to see *where* he was.[11])
Adverb clauses:	He sat *where* he did before.
	The peels were under his feet *where* he threw them.

As our examples show, place clauses can belong to any one of the three main classes of subordinate clause, noun, adjective, or

[11] The place clause used as an interrogative like this example makes up 22% of the clauses introduced by *where* and is the only form which our classification was unable to handle unambiguously. We have treated it, on the basis of its structure, with the object clauses, and will not include it in this discussion of place clauses, although it belongs just as much in that group.

adverb. The adjective clause is the most common of the three classes. We will therefore begin by discussing place clauses used as adjectives and then take up the special points that are involved in the other two cases.

The word order of the place clause is that of the corresponding simple form as far as it goes. In our material it always comes at the end of the sentence. It is always introduced by the one general word of position *where*. The main clause is one that could stand alone as a simple sentence, but the dependent clause is peculiar in that it is the only one of our seven major forms that could not stand alone. It also differs from most of the other forms in modifying a single word of the main clause. It is interesting that the place clause often involves time, the place being designated in terms of action, usually action at a particular time; for example: "He sat where he did before," or, "He went back to where he had been sitting."

Place clauses used as adverbs and as objects of prepositions are grammatically not essentially different from those used as adjectives. They can always be thought of as elliptical forms in which the clause modifies a noun which is not explicitly stated. To say, "He went back *to the place* where he had been sitting," or "He sat *in the place* where he did before," does not change the meaning of the original sentences in any way. In some cases where the place clause is used adverbially, the main clause as well as the subordinate clause may be one that could not stand alone (*cf.* our first example of the adverbial place clauses).

According to our analysis the place construction differs from those which the deaf use with greater relative frequency than the hearing (1) in that the subordinate clause modifies a single word within the main clause, and (2) in that the fact that its final clause is made complete only by being actively connected with the main clause. This last point is probably especially important in determining its position as a form which is used largely by the hearing (*cf.* p. 78).

The variety of grammatical forms which it may take and its temporal implications may also be factors that influence its position on our scale.

Sentences with relative clauses: Following are examples of the most frequently used relative constructions, arranged in groups according to the introductory pronoun:

He asked for one of the bananas *which* were in a bowl.
He ran and looked in the window *which* was open.
He got another *which* was his third.
He started to rub his stomach *which* showed that it was good.[12]

The woman *who* was busy in the kitchen came to the window.
The boy *who* came running up on the porch knocked at the window.

The picture *that* we saw was about a boy.
He saw the bananas *that* were in a bowl on the window sill.
He leaned against the pole *that* supported the roof.
She gave him something *that* will make his stomach better.

He went to the window she had left open.
That was all he could have.
The first thing she did was to give the boy a banana.
She gave him *what* was in the bottle.
He must eat *what* he has first.

In word order the relative clause follows the form of the corresponding simple sentence. Its position varies, sometimes interrupting, sometimes coming at the end of the sentence. Clauses introduced by *who* generally interrupt the action of the main clause. Clauses introduced by *which* and *what* generally follow. Clauses introduced by *that* and the elliptical form interrupt the action of the main clause in some cases (15% and 33% respectively). The connective is one that involves two directions of variation, first in gender and meaning as expressed by *who, which, what,* etc., and second, in form, *who* being inflected for case. The relative construction is one in which both main and subordinate clauses could stand alone as simple sentences. It usually serves to modify a single noun of the main clause, in our material usually in the restrictive sense, to point out the person or thing that is meant.

Thus we see that neither the form of the connective nor the position of the relative clause in the sentence is fixed. This variability itself may easily be a factor of difficulty, as is the fact that in many cases the position is one that interrupts the action of the main clause and hence requires the handling of the sentence as a single unit.

[12] These two are used only by hearing children. (*Cf.* p. 68.)

Sentences with temporal clauses: Examples of the temporal constructions most commonly used in our material are the following:

When he finished eating the banana he wanted another.
The boy had just finished the banana *when* his stomach began to hurt.
After he had eaten one he went back to look in the window.
While he was eating the third banana he became sick.
He sat on the edge of the porch *while* he ate it.
He leaned against the post *until* his mother came out.
As she was looking at him her eye caught sight of the banana peels.
She shook her finger at him *as* she picked up the banana peels.
Before it was finished he began to feel sick.
He ate one more *before* his stomach began to ache.
As soon as he had finished one he went back for another.

(The other connectives used were *just as, by the time, any time, as long as, as quickly as, whereon.*)

In this construction the word order of the subordinate clause follows that of the corresponding simple sentence. In most cases, in 90% of the temporal sentences in our material, it precedes the main clause. The relationship expressed by the temporal construction is one which requires a choice between a series of connectives involving rather fine differences in meaning. Both main and subordinate clauses are able to stand alone as simple sentences. The subordinate clause is one that belongs to the main clause as a whole.

Our first analysis of the size and kinds of language units employed by deaf and hearing children showed that the deaf tended to use relatively more of the simpler forms of expression, the hearing relatively more of the complicated ones. Corresponding differences in usage between younger and older children made it clear that differences of usage were largely to be explained in terms of relative difficulty. We have now made an analysis of differences between the seven forms of subordination used in our material to see whether they could also be presented in quantitative terms and whether differences in difficulty could also explain differences within the group of subordinate clauses between those that were used relatively more by the deaf and those that were used relatively more by the hearing. We began with two series of data, (1) the relative frequency with which each form was used by deaf and hearing children, and (2) an

analysis of the forms in terms of a series of factors which involved difficulty of structure or content. A study of our forms in terms of these two series of data shows that our original finding still holds, that the forms which the hearing use with greater relative frequency are the more difficult ones. The most significant factors are probably those which determine whether the whole sentence must have existed, implicitly at least, from the beginning, or whether it could have been formulated step by step as it was written. With the temporal and many of the relative clauses the position of the subordinate clause preceding or interrupting the main clause was important in this respect; in the place construction the fact that the final clause had to refer back to the first for its meaning.

The constructions that required a choice between connectives, interrogative, temporal, and relative constructions were used less by the deaf than forms that were otherwise comparable. The difference in the degree of reality of content seems to explain the great difference in rank between the *object clause with if* and the other kinds of object clause.

Two questions remain: (1) Why, if difficulty is an important factor in determining differences between deaf and hearing, the deaf exceed the hearing in the use of any of the complex forms. Even the sentences using the *object clause with that* are probably more difficult than simple and compound sentences; (2) Why differences between older and younger children do not correspond consistently with differences between deaf and hearing in this part of our material. In the case of the *object clause with that,* there is a marked difference between older and younger children, but the direction of difference is such that the deaf were more like the older hearing children. The age development is less in the case of the causal construction and the *object clause with if,* but in both these cases what difference there is fails to correspond to differences between deaf and hearing.

An analysis of the ways in which the different kinds of subordinate clauses are used and the relations which they express in the compositions of the two groups will help explain these apparent inconsistencies.

XI. The Ways in which the Different Forms of Subordinate Clauses Are Used in Our Material by Deaf and by Hearing Children

Causal clauses: Our analysis showed that the causal clause was one of the simplest forms of subordination. The curve (Figure 7) for hearing children rises very little with age. These facts suggest that the difference between deaf and hearing in its use is not affected by the difficulty of the construction. We can assume that the youngest hearing children were probably quite able to use it when they felt a need for it. It is probable, therefore, that the difference of frequency of use was determined by other factors. An analysis of the content of the causal clauses used by the two groups confirms this suggestion. We find that there are important differences in what is being expressed by means of causal clauses by deaf and by hearing. On the whole the deaf used it to sum up or justify what they had already said, or to state what was already obvious. The hearing used it more frequently to introduce new action, therefore in a way which does not require the use of this particular form. An example of the kind of form which the deaf used and which was relatively rare in sentences used by the hearing is: "The boy wanted a banana because he was hungry." If the boy wanted a banana at all, we may assume, in the absence of some other reason, that he was hungry. The same kind of criticism may be made of the main clause. The hearing children rarely said that the boy wanted a banana, only that he saw some bananas and asked for one. Eleven per cent of the causal clauses used by the deaf followed the general form of that statement; only one per cent of those used by the hearing.

Again we find, "He got sick because he ate three bananas," or, "His mother gave him oil because he was sick." In both cases the causal clause tells us what we already know from the action of the preceding sentences. These two together make up another twenty per cent of causal clauses used by the deaf, and four per cent of those used by the hearing.

On the other hand one-fourth of the causal clauses used by the

hearing say that the boy, eating his third banana, began to eat more slowly because he was sick. This comes earlier in the story than the examples above and is our first intimation that the stolen booty did not bring unalloyed satisfaction. It carries the action of the story on instead of merely emphasizing what is already clear.

These examples illustrate the most important differences between deaf and hearing children in the way in which they used causal clauses. We see that the hearing, when they used the causal form, usually used it to express steps in the story that could also be expressed in other ways. The deaf, on the other hand, used it to reaffirm and justify what had already been said, something which the character of the story did not make necessary, but which if it was done at all, required some special form like the causal clause. Why there is this difference in the telling of the story we cannot say. It may be that the deaf made these summarizing statements because their mastery of language was insufficient and they felt a need to stop and recapitulate as they went through the story, or it may be that they did so because their classroom training requires them to give more frequent explanations so that the teachers may be sure that they have understood what has been given at each point.

Object clause with that: This is largely the clause of indirect discourse. The plot of our narrative, because it includes conversation, calls for a larger proportion of quotation in one form or another than is found in the other studies that have been made. The hearing, as we have seen, used it with a frequency second only to that of the temporal clause, and its use increased with age with the mastery of other forms of subordination, but they used it much less than the deaf. One out of five of their subordinate clauses fell into this class, one-half of those used by the deaf. As we have seen in our previous discussion, this form differs from the juxtaposition of two simple sentences only in involving a closer linkage of the two parts. It adds a little to the interrelatedness of the paragraph as a whole. On the whole we may say that the subordination ratio for the deaf, since it is based on so great a proportion of this kind of clause, gives in

one sense too high a measure of the complexity of their style. But this form is clearly more complicated than a simple sentence, and we must answer the question why the deaf use any complex form more than the hearing do.

As we go through the story step by step, we see that one of the most direct ways of telling it is to use a series of sentences of the form, "He said that. . ." The hearing, who, as we have seen, can deal with larger units of language than the deaf, probably have a better apprehension for the style of the paragraph as a whole and vary this form by using different kinds of expression. Our answer is thus that the hearing modify the style so as to use relatively less of this form than the story taken step by step allows, while the deaf do not.

But is the fact that older hearing children use it more frequently than younger ones a contradiction of our contention that the deaf over-use it in comparison with the hearing? The curves show that the oldest hearing children use it as frequently as the younger deaf ones. This question is to be answered in terms of the structure of the paragraph as a whole. The younger deaf children used very little of any other form of subordination. Hence their paragraphs were made up largely of simple sentences, with some compound sentences and statements in indirect discourse. In these paragraphs the repetition of the clauses introduced by the one connective *that,* made the whole static and monotonous.[13] Older hearing children used the same proportion of indirect discourse as the youngest deaf ones, but in paragraphs that included a much wider variety of sentence forms, hence with a different effect on the style. Therefore, although the deaf in this case resemble older hearing children more closely than younger ones, there is no contradiction of the general fact that the deaf are retarded in comparison with hearing children in their language development.

There is another difference in the way in which the object clause with *that* is used by the two groups. In 57% of all cases

[13] Similar in its effect on style is the use of direct quotation which we have not included in this analysis. Both deaf and hearing used it less than indirect discourse, but the deaf used it three times as frequently as the hearing.

the hearing omit the connective *that;* thus: "His mother said he could have a banana." [14]

The deaf, on the other hand, omit the connective in only 21% of their object clauses of this kind. The difference is one which is felt in the style of the deaf as involving greater exactness and rigidity. The repeated use of the full form involves a definite loss of cohesion.

There was no significant age development in the frequency with which the connective was omitted.

The interrogative in indirect discourse

Three connectives were used with this form: *who, where,* and *what.* Of these *who* and *where* were used much less than *what* by the hearing, and almost never by the deaf. The form *what* was practically limited in its use in our material to two specific parts of the story for which it took the general form: "The mother asked what the boy wanted," and, "She asked him what was the matter." (The first occurred when the boy first went to the window, the second when the mother found him leaning against the post.) It is probably the very limited use that was made of this form that explains the fact that it shows less difference than any of the others between deaf and hearing, and little between older and younger children. It is a form which was relatively simple. Even the youngest deaf children were probably quite able to use it in these more or less fixed forms in which it occurred. Since they used neither of the other forms (who or where), they obviously used this one form still more frequently than the hearing did.

There is no significant difference between deaf and hearing in the proportions used in the two parts of the story, but some difference in the variety and flexibility of the forms that are used. The deaf, with one exception, used the set form "What is the matter?" The hearing used it in 73% of all cases, but also used

[14] This percentage is in agreement with the results of Thorndike's frequency rating, which gives the same rank to the complete and the elliptical forms of indirect discourse.

" what had happened," " what he was doing," " what was wrong," etc. Similarly they used a wider variety of words corresponding to *ask* in the main clause; for example, *want to know, came to see, wonder, find out, say, tell, inquire.*

The object clause with if: The use of this form is limited to a few specific points in the story and is not significantly different for the children of the two groups except in frequency of occurrence. The hearing use it with much greater relative frequency than the deaf. The age trend, on the other hand, is not strongly marked. With the hearing its use decreases somewhat with age; with the deaf it increases. The fact that the curves of the hearing do not rise with age is probably the result of the very limited way in which the form is used. It was almost always part of the fixed phrase, " came to see if," which was used in only two places in the story. The youngest hearing children had apparently mastered it and applied it as often as the material of the story required. For the deaf it involved a special difficulty, the expression of possibility, which meant that they used it less than the hearing at all age levels, but that its use increased in successive age groups.

Clauses of place: With this type of clause we see again the greater flexibility with which the hearing use any given form. With the deaf, 75% of all place clauses were used as adjectives to modify nouns, and 12% each as adverbs and as objects of prepositions (*Cf.* the examples on p. 82). The hearing used fewer as adjective clauses, 58%; they used 24% as adverbs; and 18% as objects of prepositions.[15] Our analysis showed that the last two may be thought of grammatically as elliptical forms, a kind of construction which the deaf use less in general than the hearing. (*Cf.* our discussion of the object clause with *that* p. 90 and of the relative, p. 93 below.)

This form and the remaining two are used more frequently

[15] This last form of expression is an awkward one and is an example of a case in which increased complexity means less clear expression. Nevertheless it indicates a kind of experimentation with language forms which is developmentally significant even where its immediate results are less adequate than those of other forms.

by older than by younger children, and at the same time more frequently by hearing than by deaf children. Hence they follow the general trend according to which the deaf are retarded in comparison with normal children in their use of language.

Relative clauses: The use of the relative clause involves a choice of connectives. In our material *which, who, what, that,* and the relative structure without an explicitly given pronoun, are all used. Of these pronouns *who* is used with an antecedent denoting a person, and *which* with an antecedent denoting anything except a person (a thing or in some cases a whole phrase or clause). *That* and the elliptical form are used with either persons or things. *What* is a compound form which has no expressed antecedent.

Deaf and hearing use the personal relative pronoun *who* in almost an equal percentage of their relative clauses, but it is significant that of the others the deaf prefer the unambiguous *which,* using it in 49% of all their relative clauses, while the hearing use it in only 33% and make use of *what,* of the elliptical form, and of *that* more often than the deaf do. The hearing use these three less-exactly determined forms in 43% of all their relative clauses, the deaf only 22%. Table XIII and Figure 8 present these comparisons.

TABLE XIII

PERCENTAGE OF THE TOTAL NUMBER OF RELATIVE CLAUSES INTRODUCED BY EACH OF THE DIFFERENT RELATIVE PRONOUNS IN COMPOSITIONS OF DEAF AND HEARING CHILDREN

	Hearing	Deaf
Which	32	49
Who	24	28
That	20	11
What	14	4
Elliptical form	11	8

It is clear that *what* is an especially complicated form, since it has no expressed antecedent and carries the meaning of *that which* in the single form, thus belonging at once to the main and to the subordinate clause. The relative, as used by both deaf and hearing, is omitted less often than the connective *that* of the

object clause,[16] although more often by hearing than by deaf. This difference between deaf and hearing is in the same direction as the difference in the use of the elliptical form in other cases and probably belongs to the greater exactness and rigidity of style which seems characteristic of the deaf (*Cf.* p. 90). In regard to the use of *that* as a relative we may suggest that the deaf avoid this word as a pronoun, since it is so strongly established for them as the connective of indirect discourse, in which it plays grammatically a very important role.

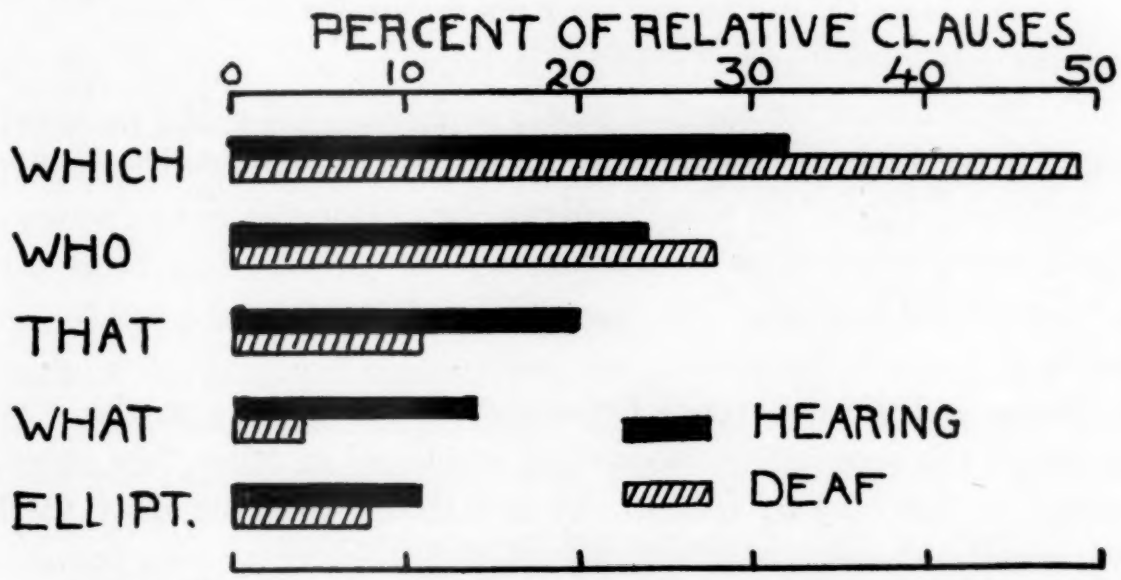

FIG. 8. Percentage of the total number of relative clauses introduced by each of the different relative pronouns used in compositions of deaf and hearing children.

As we have seen, it is likely that the position of the relative clause on our scale was influenced by the fact that it may interrupt the action of the main clause of the sentence. But within the group of relative pronouns we do not find that there is a strict correspondence between the frequency of use of a connective and the position of the subordinate clause that it introduces. Table XIV shows for each pronoun the percentage of cases in which the subordinate clause interrupts the action of the main clause. Although the pronoun that the deaf use most frequently, *which,*

[16] This is in agreement with Thorndike's frequency list which indicates that the elliptical relative form occurs less often in ordinary usage than the complete form.

is one whose clause always follows the main clause, it is likely that the differences in meaning and use discussed above are still more important. The deaf use *who,* a pronoun whose clause interrupts the main clause, with somewhat greater relative frequency than the hearing. *That,* which the hearing use with greater relative frequency, usually introduces a clause at the end of a sentence.

TABLE XIV

PERCENTAGE OF CASES IN WHICH THE DEPENDENT CLAUSE INTERRUPTS THE MAIN CLAUSE SHOWN FOR EACH OF THE RELATIVE FORMS USED IN THE MATERIAL OF THIS STUDY

Pronouns	Percentage of Cases in Which the Dependent Clause Interrupts the Action of the Main Clause
Who	99
Which	3
That	15
What	7
Elliptical form	33

There is little difference between the two groups in the way in which the separate pronouns are employed in telling the story, except in the case of *which.* It is striking that the deaf used this word only with concrete objects as antecedents: viz., *banana, window, skin, ground,* and *medicine.* The hearing used all of these words and in addition words like *another, one, three,* and all the more complicated forms in which a clause or phrase serves as the antecedent of the pronoun; for example, "He starts to rub his stomach which shows that he liked the banana," or, "His mother put up one finger which meant that he could only have one banana."

Temporal clauses: This form, in which hearing children are so far superior to deaf, differs from the others of our material in that the dependent clause usually preceded the main clause. This was true in 90% of all cases. A closer examination of the temporal construction used by deaf and hearing children shows that the deaf, when they used the temporal clause at all, followed this sequence less often than the hearing. Twenty-five per cent of their temporal clauses as compared with 8.9% of those used

TABLE XV

PERCENTAGE OF THE TOTAL NUMBER OF TEMPORAL CLAUSES INTRODUCED BY EACH OF THE DIFFERENT CONNECTIVES USED IN COMPOSITIONS OF DEAF AND HEARING CHILDREN

	Hearing	Deaf
When	.55	.58
After	.30	.12
As	.05	..
Until	.03	.06
Before	.02	..
While	.02	.20
As soon as	.005	.05
Others	.025	..

by the hearing, are of what is probably structurally the simpler form, in which the dependent clause follows the main clause. The relative frequencies of the different connectives used by the two groups shows this difference again. Table XV and Figure 9 give for deaf and hearing the percentage of temporal clauses introduced by each of the different connectives. Table XVI shows, for each of the principal connectives, the percentage of cases in which the subordinate clauses preceded the main clause in our material. The one connective that the deaf used with significantly greater

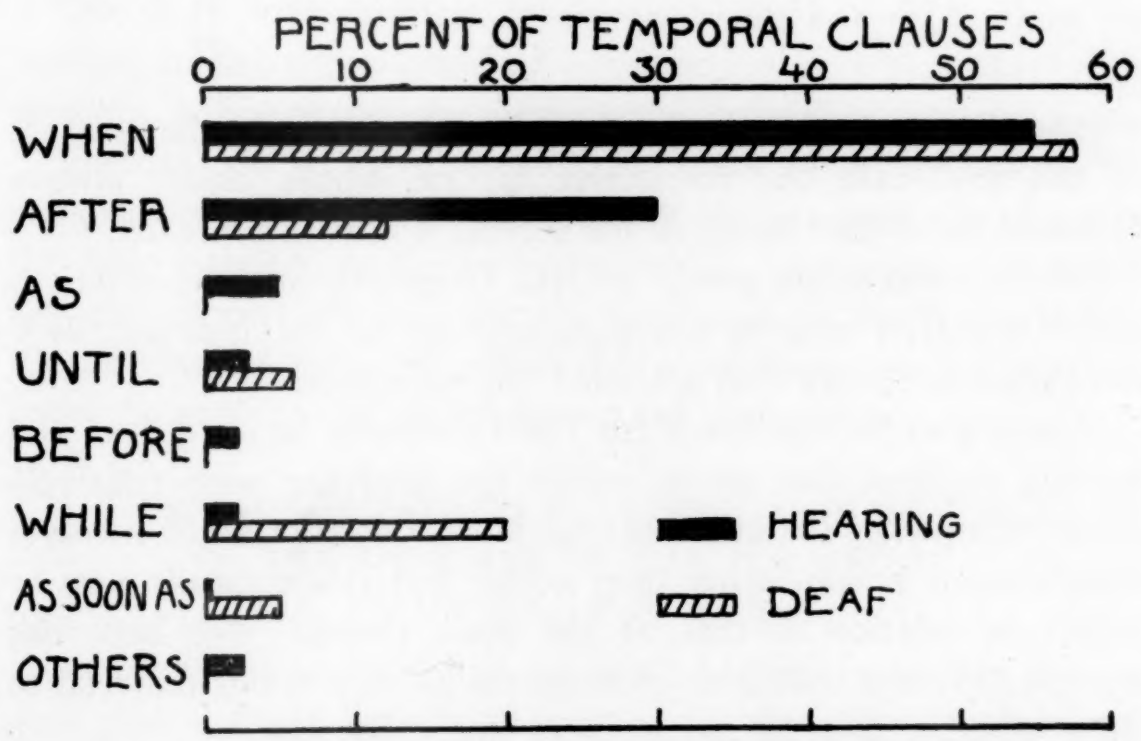

FIG. 9. Percentage of the total number of temporal clauses introduced by each of the different connectives used in compositions of deaf and hearing children.

relative frequency than the hearing was *while,* which was used in clauses following the main clause more often than any other except *until. When,* which deaf and hearing used with approximately equal relative frequency, and *after,* in which the hearing were significantly superior, usually served to introduce clauses which preceded the main clause. This was true in 89% and 99% respectively of all cases. *As* and *before,* which were used only by the hearing, introduced clauses which precede in 74% and 84% respectively of all cases. *Until* and *as soon as,* which are among the less common connectives of the first seven, are used

TABLE XVI

PERCENTAGE OF CASES IN WHICH THE DEPENDENT CLAUSE PRECEDES THE MAIN CLAUSE SHOWN FOR EACH OF THE TEMPORAL CONNECTIVES USED IN THE MATERIAL OF THIS STUDY

Temporal Connectives	Percentage of Cases in Which the Dependent Clause Precedes
When	89
After	99
While	59
Until	00
Before	85
As soon as	100
As	74
Others	94

with somewhat greater frequency by the deaf than by the hearing. In the first case the connective is one whose clause always followed the main clause; in the second it always preceded.

Of the others, the group of less frequently used connectives which occurred only in the compositions of the hearing, 94% were used in clauses that preceded the main clause.

It may also be significant for the differences between deaf and hearing children that *while,* which the deaf use with relatively greater frequency than the hearing, is a connective which involves simultaneous action rather than action that is specifically past or future in relation to that of the main clause. We have not enough different examples of temporal clauses in our material to show whether this difference is an important one.

Table IX shows clearly that the hearing use a greater variety of connectives in the temporal construction than the deaf. There

are altogether fourteen different forms used in our material by the hearing to introduce temporal clauses, only five used by the deaf. Thus we see that there are differences between the deaf and the hearing within the groups of subordinate clauses that correspond to differences already discussed in considering the relative frequency with which single kinds of clause were used by the two groups. Our previous analysis showed that any form whose use involved a choice of connectives depending on differences in meaning was used less by the deaf than by the hearing. We see now that within each clause group where such a choice was possible, the deaf used relatively fewer different forms than the hearing, or (in the case of the relative) showed a less equal distribution of the forms that were available.

Similarly our analysis of interrogative expressions and of antecedents used with relative pronouns showed that the hearing used a wider variety of expressions, and in the case of the relative with *which,* fewer antecedents that were concrete objects. In using the relative construction the deaf preferred those forms whose antecedents were fixed as persons or things and used relatively few of those whose antecedents were variable.

The deaf used elliptical forms relatively less often than the hearing in the three kinds of construction in which they were possible, although for the relative the difference was not great.

The deaf, as we have already seen, used relatively few of the constructions in which the subordinate clause commonly preceded the main clause; *i.e.,* the temporal forms. A comparison within this class shows further that the deaf used relatively more than the hearing of those in which the subordinate clause departed from the general rule and followed the main clause.

XII. General Differences Between Language Structure of the Deaf and of the Hearing in Terms of Our Analyses

As far as the material that we studied is representative, we can now give a fairly definite picture of the language structure of deaf as compared with hearing children. First, the deaf use relatively simple language units. Their sentences are shorter

than those of the hearing. They use relatively fewer verbs in either coördinate or subordinate clauses than the hearing, more in simple sentences. This same difference of pattern shows again when we consider the finer differences. The hearing are superior to the deaf in the use of complex forms whose structure requires that two clauses be handled as a single unit. Those of which the deaf use relatively more than the hearing are the ones which can be built up clause by clause as they are written.

Differences in the size of the language unit on a different level may also help explain why the deaf used causal clauses and *object clauses with that* more than hearing children; the fact that the deaf had less comprehension of the paragraph as a unit may account in part for their tendency to repeat the form "he said that" in their compositions. The hearing used more different ways of indicating the questions and answers that were part of the story. Similarly the deaf may have used the causal clause to recapitulate what had already been told just because the structure of the whole paragraph was looser and they felt a need to bind it together in some way.

Further, the deaf used relatively few of the forms whose meaning required precision of use. Forms involving choice of connectives corresponding to shades of meaning and forms which modified a single word of the main clause were used by them relatively less than forms which otherwise were of the same degree of difficulty.

It is also characteristic of the style of the deaf that it included more fixed forms that could be learned and that any kind of variability seemed to introduce additional difficulty. A form in which the word order of the subordinate clause was different from that of the corresponding simple sentence is relatively less used by the deaf than others of the same degree of difficulty. The forms in which the position of the main clause varies are used relatively less than those in which it is fixed. Probably the avoidance of elliptical forms by the deaf is also an indication of a preference for a single, fixed expression.

The whole picture indicates a simpler style, involving relatively rigid unrelated language units which follow each other with little

overlapping of structure or meaning.[17] To a considerable extent it is part of the general educational retardation of the deaf, but some of the differences, for instance in the use of the causal form, or in the use of possibility, may also indicate another direction of difference which we may describe as one in attitude toward the subject of the composition. We know that the choice of language forms in a given composition is determined to some extent by the subject of the composition. In our work we held that factor constant and the differences that occurred must be explained by the other two factors: (1) differences between the two groups in what they are trying to say; (2) differences in the forms which they employ. We have shown that on the whole the forms which the deaf use relatively less often than the hearing are the more difficult ones and usually those which younger children use relatively little in comparison with older ones. The single cases in which the deaf resemble older rather than younger children can usually be treated as indicating immaturity of style if the composition as a whole is considered.

But whether the differences between the groups in what they say about the subject, for instance the fact that the deaf tend to interrupt the narrative and explain *why* more frequently than the hearing or that they rarely speak of what is only a possibility rather than a concrete fact, are reduced to terms of relative difficulty, is not so clear. Only further studies can answer this question, but it seems more likely that the difference between the deaf and the hearing cannot be fully expressed in quantitative terms as the degree of retardation and that they represent differences not merely of skill in the use of the language forms but in the whole thought structure.

XIII. SUMMARY:

1. A quantitative analysis of differences between deaf and hearing children in sentence structure showed:
   (1) The sentences of the deaf were shorter, both in number of words and in number of clauses than those of the hearing.

[17] This is in agreement with Huber's description of the language used by the deaf as rigid and stiff with stereotyped repetitions.

(2) The deaf used relatively more simple, fewer compound and fewer complex sentences than the hearing.

(3) The deaf used fewer verbs in subordinate and coordinate clauses than the hearing, more in main clauses.

(4) Differences in length of composition and in length of clause were unimportant.

(5) The deaf used relatively more infinitives, fewer gerundive and participial constructions than the hearing.

(6) The deaf used relatively more prepositional phrases.

(7) In all these comparisons, except those of the infinitive and prepositional phrase, the performance of the deaf resembled that of less mature hearing children.

2. A comparison of the seven kinds of subordinate clause that occurred most frequently in our material showed:

(1) The hearing used relatively more of temporal, relative, place clauses and object clauses with *if* than the deaf.

(2) The deaf used relatively more than the hearing of object clauses with *that* and causal clauses.

(3) The interrogative in indirect discourse was used with equal frequency by the two groups.

(4) Differences between deaf and hearing did not fully correspond to differences between younger and older children. In the case of the object clause with *that*, the deaf resembled older rather than younger hearing children. In the case of the causal clause and the object clause with *if*, there were important differences between the two groups with no correspondingly great differences between younger and older children.

3. An analysis of the different forms of subordination in terms of factors of relative difficulty showed differences between them that correspond to differences in frequency of use between deaf and hearing children. It was suggested that the following items make for difficulty and that therefore forms involving them are used less by deaf than by hearing children:

(1) Word order of the subordinate clause differing from that of the corresponding simple form.

(2) Differentiation of meaning involving a choice of connectives.

(3) Structure requiring the organization of the whole sentence, implicitly at least, from the beginning.

(4) Content expressing possibility rather than actuality.

(5) Any sort of variability of form.

4. A comparison of the ways in which each of the different subordinate forms was used by the two groups showed differences between deaf and hearing in the use of some of the forms that correspond to differences shown by the previous analyses.

(1) Use of elliptical forms: Within the kinds of clauses in which elliptical forms ever occurred, the deaf omitted the connective or introductory word of a subordinate clause less often than the hearing.

(2) Connectives: Within the groups of clauses in which a choice of connectives occurred at all, the deaf tended to use fewer different forms than the hearing. In using the relative they prefer the forms which have definite personal or object antecedents and use relatively fewer than the hearing of the less definite forms.

(3) Construction of sentence: Within the class of temporal clauses the deaf used fewer than the hearing of those in which the subordinate clause preceded the main clause.

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V. A STUDY OF THE SPONTANEOUS VOCALIZATIONS OF YOUNG DEAF CHILDREN

I. Introduction

The speech development of hearing infants may be said to begin with the reflex cries of the first few weeks. These are followed by stages of random babbling, experimentation with the production of sound, and eventually, imitation of the sounds which the child hears about him. The deaf child is said to babble in a manner comparable to that of the hearing infant, but he is never able to imitate the speech of others, and his vocalizations continue with no organization for speech purposes until he is taught by special methods to differentiate between sounds and to combine them properly.

Deafness is often not discovered in infants because of the natural character of their early vocalizations, and it would be difficult to secure a group of deaf infants for observation at the age when a similar group of hearing infants would be babbling and experimenting with sound formations. The present study was made in an attempt to discover something of the nature of the spontaneous vocalizations of children known to be deaf, ranging in age from four to seven years. The subjects were fourteen children in the Preparatory Classes of the Clarke School. These children were chronologically far past the "babble" period of speech development, which occurs normally from six to nine months of age, and it is difficult to determine whether their vocalizations when they were at the chronologically normal babbling age would have been comparable to those of hearing infants. Factors of social, mental, and physical development may influence the amount and range of the deaf child's vocalizations when he has reached the age of four or five years.

The problem was outlined as follows:

1. What sounds and combinations of sounds do deaf children make before speech instruction is given? What speech sounds

are most frequently used? Are they used separately or in combination with one another?

2. What influence does the amount of residual hearing have in these prelinguistic vocalizations? Are there other factors which affect the amount and range of vocalization before speech instruction is given?

3. What is the function of these vocalizations? Do different situations appear to stimulate different kinds and amounts of vocalization? Can specific meanings ever be attached to the speech sounds of deaf children?

4. Do young deaf children carry over into their spontaneous vocalizations any of the speech sounds they have been taught in school?

II. Literature

Occasional references have been made to the vocalizations of deaf children,[1] as in the statement of Stern that "even the deaf-mute child babbles in quite a normal way, so that the child's infirmity may pass unnoticed for some time" (7, p. 141). Fröschels, as recently as 1932, has gone so far as to suggest that practically all deaf children present problems in behavior, "a characteristic which may be due to the fact that the profuse motor release connected with speech is impossible in their case" (1, p. 97). This suggestion is open to question. Deaf children, as observed at the Clarke School, give no evidence of unusual behavior problems; and this study will show that it is possible for them to secure a motor release in connection with the speech processes by means of extensive vocalizations.

Kampik (4, pp. 56 ff.) writes that the speech organs of the deaf child are as well developed as those of the hearing, and that the deaf child is not necessarily mute. For this reason, deafness often may not be discovered until the child's failure to speak is noted when he is a year and a half old, or more. Until

[1] A few studies have been made of the vocalizations of the deaf blind but these are of older children and are therefore not directly comparable with our material. (*Cf.* Francis Lieber, Smithsonian Contributions to Knowledge, 1850, Vol. 2, Article 2, and Dorothea McCarthy, Journal of Genetic Psychology, 1929, 36, 482–484.

this time, the child has cried and laughed and, it is said, babbled. He has even turned around when a door slammed, or when someone entered the room, because he felt the vibrations attending these occurrences. From a questionnaire sent out to the parents of the deaf children in an institution for the deaf Kampik concludes that deaf children babble almost as hearing children do.

A number of studies have been made of the speech development of hearing children, but with attention devoted chiefly to the development of vocabulary and to defective speech. The observations made of prelinguistic vocalization of hearing children have not been extensive and the information they give is difficult to combine into an integrated body of material.

A large number of the studies of speech development of hearing children has been summarized in the Iowa University Study, "Speech Sounds of Young Children," (9) and in the "Twenty-eighth Yearbook" of the National Society for the Study of Education (8). The latter gives abstracts of the studies listed. A few other studies, such as those of McCarthy (6), have been made, but they have no direct bearing on the present study.

Most authorities agree that vowel sounds predominate in the early babbling of hearing children, and the first consonants appear most frequently in an initial position in a syllable. There is little agreement as to what consonants appear first, although this may indicate that different children use different speech sounds in their first babbling.

III. Subjects

The children observed in this study formed the two beginning classes at the Clarke School. The older group, Class A, was made up of eight children ranging in age from 4:8 to 6:10. The six children of the younger group, Class B, ranged in age from 3:10 to 4:11. These groups were typical beginning classes. Only one of the children had ever been in school before. The individual children varied as do similar groups of hearing children in social and mental development, and their family backgrounds presented considerable differences with respect to economic status and general culture.

Hearing tests are given to all children who enter Clarke School by the Research Department for the Study of the Heredity of Deafness (2, 3). With their aid, the subjects of this study have been divided into two groups according to the degree of their hearing loss. Group I included six children with residual hearing that may have been sufficient to have influenced the nature and amount of their spontaneous vocalization. Group II was composed of eight profoundly deaf children who had probably never experienced sound to a degree that would have affected their vocalizations. Table I shows how the children of Classes A

TABLE I

CLASSIFICATION OF CHILDREN ACCORDING TO HEARING LOSS

	Group I Hard-of-Hearing		Group II Profoundly Deaf	
Class A	Ak. 6:3 Dr. 4:8 Pb. 5:6	Br. 6:6 Rn. 6:9	Ll. 5:8 Rz. 6:7 Jh. 6:10	
Class B	Kl. 4:9		Ri. 4:10 Di. 4:9 Ro. 4:11	Bu. 4:0 Bo. 3:10

and B were classified according to hearing loss in Groups I and II. The figures following the children's initials denote their ages in years and months. The Children of Class A were, on the whole, older than those of Class B.

With but one exception, the children in Class B were profoundly deaf. In Class A, five of the eight children had some hearing that might have influenced the nature of vocalization.

IV. PROCEDURE

Auditory and graphic methods, involving the use of the phonograph or kymograph for the recording of sound, were dismissed as being impracticable for use in this study. Young deaf children vocalize most spontaneously in situations of free play, and the limitations that would have to be imposed on the subjects to secure good phonographic or kymographic records would make it almost impossible to obtain results of any value.

In using the observational method in this study, the observer recorded only those sounds that occur in English speech, using

a broad transcription of the International Phonetic Symbols. Whenever a consonant was heard as an imperfect approximation of an English consonant, it was recorded as such, but in parenthesis. The transcription used was as follows: [2]

Consonants [3]

p — *pee**p***	n — *noo**n***	ð — either	r — ***r**ear*
b — *bi**b***	k — *coo**k***	f — *fi**fe***	l — ***l**ull*
m — *mai**m***	g — *gi**g***	v — *va**l**ve*	h — ***h**ail*
t — *too**t***	ŋ — *si**ng***	s — *ce**a**se*	w — ***w**ail*
d — *dee**d***	θ — *e**th**er*	tʃ — ***ch**urch*	j — ***y**ou*

Vowels

i — b***ee**t*	ɛ — s***e**t*	ɔ — ***a**ll*	ʌ — s***u**n*
	æ — s***a**t*	U — p***u**ll*	ə — sof***a***
	ɑ — f***a**ther*	u — p***oo**l*	ɜ — b***ir**d*

Diphthongs

aɪ — ***i**ce*	au — h***ou**se*	ɔɪ — b***oy***	ou — g***o***
eɪ — c***a**ve*			

In addition to vocalizations, the observer recorded significant activities which the vocalizations accompanied and, whenever possible, made note of gestures of communication, whether they were accompanied by vocalization or not.

Observations were made in three different types of situations with a view to securing as representative examples of spontaneous vocalization as possible. The number of observations made in each of the situations chosen for observation is shown in Table II.

Observations made in the first type of situation involved the recording of the vocalizations of each child during one hour of free play. All situations described as free play occurred either

TABLE II

NUMBER AND TYPE OF OBSERVATIONS

	Hours of Individual Observation in Free Play	Hours Observing Whole Class in Free Play	5–10 Minutes in Experimental Situation
Class A (8 hours for the class)	1 per child	15	7 per child
Class B (6 hours for the class)	1 per child	14	9 per child

[2] Compare Webster's New International Dictionary of the English language, Second Edition, Unabridged, p. xxii.

[3] The consonants z, ʃ, ʒ, dʒ, and hw did not occur in the vocalizations of the deaf children.

in an indoor playroom or on the outdoor playground, while the children were playing without close supervision.

The second type of observation was a general observation of an entire class for periods of one hour each, of which 15 were made for Class A, 14 for Class B. These observations were also made in free play situations, and for the most part, the vocalizations of the members of an entire class were not so numerous but that the observer was able to record all of their vocalizations.

The third type of observation was made in an experimental situation that was devised to determine whether similar responses might be provoked from the different children under controlled conditions. Each class was taken as a group to the experimental room, which was equipped with familiar playthings. After they had become familiar with the room, the children were brought back on succeeding days, sometimes singly, sometimes (if necessary) in pairs, when a braver child would accomplish a timid one. On each of these subsequent visits, the observer seated herself at one side of a table, and allowed some salamanders to crawl from a jar onto a tray. She played with them, and if the child was interested and not afraid, she would offer him one. When the child's interest lagged, or when he had played with the salamanders for several minutes, he was taken back to the schoolroom. The daily procedure was the same with each child, unless the child of his own accord played with the salamanders before the observer let them out of the jar. After the first few days, the observer waited for a brief time to see if the child would initiate the play.

After several days of playing with the salamanders, each child was brought to the room and no salamanders were presented. Records were made of all vocalizations during the visits, and particular note was made of the method of inquiry used by the children when they found the salamanders were missing. In all, the children of Class A visited the experimental room 7 times each, and those of Class B visited 9 times each.

Each child in Class A was observed for 1 intensive hour, 15 hours in free play along with the other members of his class, and between 35 to 70 minutes in the experimental situation; or between 16 hours, 35 minutes and 17 hours, 10 minutes,

altogether. Each child in Class B was observed for 1 intensive hour, 14 hours in play with the other members of his class, and from 45 to 90 minutes in the experimental situation, or between 15 hours, 45 minutes and 16 hours, 30 minutes, altogether. While there was not an absolute correspondence between the time spent observing the children of the two classes, the slight disparity is not so great that it would influence the nature of the results obtained. The observer felt that the data presented a representative and comparable picture of the range and frequency of the vocalizations of each child.

V. The Data and Their Significance

A. The sounds made and their frequency.

The speech sounds made by the deaf children in the two classes, A and B, and the frequency with which they occurred are shown in Table III.

The vowel sounds are obviously the most commonly used speech sounds. The indefinite vowel *ə* is by far the most frequently recorded vowel, representing 30.96% of all the sounds recorded. It is interesting to note that ɑ, ʌ, and *æ*, which are formed with the tongue in a low position and are known as middle vowels, come next on the list according to frequency, while *u* and *i*, extreme back and front vowels, are among the most infrequently used by the deaf children. The terms "back" and "front" denote a raising of the front or back of the tongue in the formation of these vowels. The frequency of the vowels is not directly proportional to their departure from the mid-position, but in general the middle vowels are more frequently produced, the back and front vowels less frequently.

Of the consonants, *b* is easily the most frequent, with *m* second. These are both voiced labials which the deaf child could see formed on the lips of other people, although this fact may not be the reason for their frequency. Labial consonants may be more easily made in connection with the deaf child's vocalization of vowels, or they may serve as a sort of lip exercise. Voiced consonants occur much more frequently than unvoiced sounds

TABLE III

RANGE AND FREQUENCY OF ALL SPEECH SOUNDS MADE BY THE DEAF CHILDREN AND THE PER CENT OF THE TOTAL NUMBER OF RECORDED SOUNDS REPRESENTED BY EACH INDIVIDUAL SOUND

Consonants	Frequency	Per Cent of Total	Vowels	Frequency	Per Cent of Total	Diphthongs	Frequency	Per Cent of Total
b	493	10.24	ə	1489	30.96	aɪ	37	.77
m	235	4.90	ɑ	618	12.84	au	35	.73
j	128	2.66	ʌ	369	7.69	ou	27	.56
d	81	1.68	æ	182	3.78	eɪ	3	.06
h	75	1.56	e	158	3.16	ɔɪ	3	.06
w	69	1.43	U	120	2.49			
g	68	1.41	ɔ	84	1.75	—	—	—
l	65	1.35	I	75	1.56	5	105	2.18
n	62	1.29	ɛ	74	1.54			
p	54	1.12	u	50	1.04			
f	25	.52	i	40	.83			
t	20	.41	ɜ	5	.10			
ɵ	18	.37						
k	16	.33						
ð	9	.19						
v	8	.17						
r	5	.10						
ŋ	4	.08						
s	2	.04						
(tʃ)	1	.02						
—	—	—	—	—	—	—	—	—
20	1438	29.87	12	3264	67.74	4	6	.12

Consonant Combinations*	Frequency	Per Cent of Total
pw	2	.04
nj	2	.04
tj	1	.02
bl	1	.02
—	—	—
4	6	.12

Frequency of Sounds Used by All Children

Consonants	1438
Vowels	3264
Diphthongs	105

Range of Sounds Used by All Children

Consonants	20
Vowels	12
Diphthongs	5

* All consonant combinations except bl were made by one child who had a great deal of hearing. Aside from these cases there were no other occurrences of consonant combinations.

that are similar in their formation; for example, *b* and *m* occur more frequently than *p; d* and *n* more frequently than *t; g* more frequently than *k*. ɵ and *f* are exceptions, occurring more frequently than ð and *v*. However, these latter sounds occur so infrequently that this fact is of little significance. The nasal consonants *m* and *n* occur less frequently than *b* and *d*, which are formed in the same position.

B. The occurrence of speech sounds in relation to one another.

Table IV shows the occurrence of the single speech sounds as they were used by the deaf children and the number of times each sound occurred in combination with others. The twelve different vowels were uttered 1540 times as single syllables; that

TABLE IV

FREQUENCY OF SPEECH SOUNDS OCCURRING SINGLY AND IN COMBINATION

Consonants	Occurrences Singly	Occurrences in Combination
b		493
m	7	228
j		128
d		81
h		75
w		69
g		68
l		65
n	4	58
p	6	48
f	7	18
t		20
ɵ		18
k	6	10
ð		9
v		8
r		5
ŋ		4
s	1	1
(tʃ)		1
	31	1407

Vowels	Occurrences Singly	Occurrences in Combination
ə	843	646
ɑ	253	365
ʌ	94	275
æ	91	91
e	94	64
U	27	93
ɔ	51	33
I	27	48
E	14	60
u	15	35
i	26	14
ɜ	5	0
	1540	1724

Diphthongs	Occurrences Singly	Occurrences in Combination
aɪ	18	19
au	10	25
ou	7	20
eɪ	3	0
ɔɪ	0	3
	38	67

is without being combined with consonants. This represents almost half of the total number of vowel occurrences. In some cases, when a consonant occurred between two vowels, the consonant was held so long that it was difficult to determine in which syllable it belonged, as in a combination like *ama*. In such cases, both vowels were considered to be in combination with the consonant, although without actual kymographic records, one could safely assign to the consonant only the releasing function in the second syllable.

Four diphthongs occurred singly on 38 different occasions. Six different consonants were given without being combined with a vowel, 31 times in all. This is significant because in normal speech the function of the consonant in the syllable is always to release or arrest a vowel sound. Consonants never occur singly in the English language, although vowels do so occur, as in such words as a, awe, owe, eye, etc.

Table V shows the frequency with which consonants were used in an initial or releasing position with relation to the vowel in a syllable, and the number of times the different consonants served to arrest the vowel sound in the syllable. A great preference is shown for the releasing function, since consonants occur in this manner 1308 times as opposed to their occurrence 99 times in an arresting position. All twenty consonants were used at least once in the releasing position, but only 10 were used in the arresting function.

Latif (5, 62) calls attentions to the reduplication of syllables such as *a-a, ma-ma, a-ta,* etc., which is frequently observed in the babbling of hearing children, a phenomenon which continues from the babbling period until the fifth year. These repetitions, he writes, are " far less in evidence in infants born deaf."

No attempt was made in recording the vocalizations of the deaf children to note systematically such reduplications of syllables as Latif mentions, so that the exact number of such repetitions occurring in the vocalizations of the deaf children is uncertain. However, it can safely be said that our records show this phenomenon to be common in the babbling of the deaf. Frequently such syllable sequences as a-*b*a, a-*m*a, a-*b*a-*b*a, etc., were noted, and these repetitions were found in the records of every child.

TABLE V

FREQUENCY OF CONSONANTS IN RELEASING AND ARRESTING POSITION

Consonant	b	m	j	d	h	w	g	l	n	p	f	t	θ	k	ð	v	r	ŋ	s	(tʃ)	Total
Releasing Position	483	184	128	81	75	69	68	61	47	41	15	20	5	9	6	8	5	1	1	1	1308
Arresting Position	10	44						4	11	7	3		13	1	3		.	3			99

C. Differences between Groups I and II.

Using the classification into deaf and hard-of-hearing groups as outlined in Table I, the average number of times each sound was used by the members of each group is indicated in Table VI.

TABLE VI

AVERAGE FREQUENCY PER CHILD FOR DIFFERENT KINDS OF SPEECH SOUNDS AS THEY WERE GIVEN BY GROUPS I AND II

Consonants	Average Frequency Per Child		Vowels and Diphthongs	Average Frequency Per Child	
	Group I	Group II		Group I	Group II
b	33.50	36.37 *	ə	128.67	127.12
m	5.67	25.12 *	ɑ	46.17	42.62
j	8.00	9.75 *	ʌ	23.50	28.50
d	11.33	1.62	æ	15.17	11.37
h	3.83	5.12 *	e	8.50	13.27
w	7.16	3.25	U	10.50	7.12
g	2.83	6.37 *	ɔ	7.67	4.87
l	5.16	4.25	I	3.33	6.87
n	6.67	2.75	ɛ	3.50	5.37
p	4.17	4.12	u	5.33	2.25
f	3.33	.50	i	3.00	2.75
t	2.33	.62	aɪ	.67	4.12
ɵ	3.00	.00	au	2.50	2.50
k	1.83	.62	ou	4.00	.47
ð	.50	.12	ʒ	.00	.75
v	.16	.62 *	eɪ	.16	.25
r	.50	.12	ɔɪ	.16	.00
ŋ	.16	.04			
s	.33	.00			
(tʃ)	.16	.00			
20	101.12	101.74	17	262.83	260.50

* More frequently used by Group II.

The sounds are arranged in order according to the combined frequency of occurrence for the two groups. There is almost no difference between the two groups with respect to the average frequency with which the different types of sounds are used. Vowels and diphthongs occur on an average of 262.83 times per child in Group I, 260.5 times in Group II; consonants averaged 101.12 times per child in Group I, 101.74 in Group II.

The range of sounds shows no important differences between

the two groups. There are only three sounds, s, ɵ, and *t*ʃ that are made by one group (the hard-of-hearing) and not by the other. But an examination of the frequency with which single sounds are used shows that those used by the profoundly deaf with greater relative frequency than by the children with some hearing (b, m, j, h, g and v) are for the most part sounds which are used most often by both groups; those in whose use hard-of-hearing exceed profoundly deaf are sounds which are used rela-

TABLE VII

DIFFERENCES IN RANGE OF SPEECH SOUNDS AS USED BY DIFFERENT CHILDREN IN GROUPS I AND II

	Group I		
	Vowels and Diphthongs	Consonants	Vowels, Diphthongs, and Consonants
Number possible to use.....	17	20	37
Fewest used by any child....	8	9	17
Most used by any child.....	14	17	31
Average for Group.....	11.83	13	24.83
	Group II		
	Vowels and Diphthongs	Consonants	Vowels, Diphthongs, and Consonants
Number possible to use.....	17	20	37
Fewest used by any child....	6	6	12
Most used by any child.....	16	13	29
Average for Group.....	11	9.25	20.25

tively less by the two groups. One may probably assume that the sounds which the deaf children use most frequently are in some way easier[4] for them, therefore that those which the profoundly deaf children made more frequently than the less deaf children were largely sounds that were easy to produce.

Table VII shows the variations in range of sounds produced by the different children within the two groups. In Group I, the average range of vowels and diphthongs produced by each member of the group was 11.83 out of a possible 17, with a minimum of 8 as the fewest used by any child, and a maximum

[4] The fact that not all of the sounds made more frequently by Group II than by Group I are necessarily easier for teaching is not significant for our consideration since the process of learning a sound by visual imitation is a very different process from that of spontaneous vocalization.

of 14 as the largest number used by any one child. In Group II, the group average per member was 11, the range from 6 to 16 for different members of the group.

A slightly greater difference appears between the two groups in regard to consonants. Group I had an average range per child of 13 consonants, while the children of Group II averaged 9.25, and the range for individuals in Group I was 9 for the child with

TABLE VIII

RANGE AND FREQUENCY OF DIFFERENT SOUND COMBINATIONS FOR GROUP I AND GROUP II

Group I

Child	Range	Frequency
Pb	105	393
Dr	80	137
Kl	76	282
Rn	45	145
Ak	42	94
Br	40	108
Average per child	64.67	193.17

Group II

Child	Range	Frequency
Ll	94	258
Rz	84	553
Di	74	326
Jh	70	387
Bo	41	156
Ro	29	158
Bu	23	107
Ri	19	61
Average per child	54.25	250.75

the fewest consonants, to 17 for the child with most consonants as against 6 to 13 for Group II. These differences might indicate that the range of consonants employed by children with more hearing is greater than that of children who are completely deaf, although no such difference is apparent in the case of vowels and diphthongs. However, with so few cases and such small differences, it is impossible to make any such generalization.

So far, the individual speech sounds have been considered without regard for the various combinations in which they were used by the children; *i.e.*, the variety of consonant-vowel combinations. Table VII shows that Group I, with an average number

per child of 64.67 combinations, surpassed Group II, in which an average number of 54.25 combinations were used. The difference between these averages is not very significant, however, because of the great individual differences. In the matter of frequency of the different sound combinations, Group II has a higher average per child than Group I, but again the individual differences are so great as to make the difference between the groups unreliable.

There is no positive indication that the presence of a serviceable amount of hearing plays a greater part in influencing the variety or amount of vocalization than other factors. For example, in Group I there were children with considerable hearing who were shy, unobtrusive members of their class group (Table VIII, Br and Ak). They vocalized very little. In Group II, two children with little hearing were self-centered, out-going and domineering, vocalized a great deal, and with considerable variety (Table VIII, Rz and Jh). Personality certainly influences the nature of the vocalizations of deaf children. It is difficult to determine what part intelligence may play, but it is possible that it also may contribute to the amount and nature of vocalization.

D. The function of vocalization for the young deaf child.

Two functions of vocalization are apparent in the observations made in this study. First, and by far the most important, is the occurrence of vocalization as an accompaniment to general activity in play. This function occurs also in the play of hearing children. McCarthy (**6**, 284) writes that "some writers maintain . . . that vocal play, the exercise of the vocal organs, is just as instinctive as the random movements of the gross muscles of the body."

As a second function, one finds vocalization accompanying communication, although not essential to it. The records of situations in which communication occurred show that the children seldom used vocalization alone for purposes of communication. Occasionally they tried to attract attention by crying out,

but usually even these cries accompanied gestures, often a pointing gesture indicating the direction of the interest. In most cases vocalizations which accompanied gestures seemed only a part of the general activity, like the vocalizations accompanying play activity. On the whole there was an increase in vocalization which accompanied increases in general activity whenever anything occurred to increase the child's excitement.

It was interesting that these children, who had not yet acquired vocabularies of conventional spoken words, almost never used sound alone to represent an object. In a few cases a child with more hearing than most of the group used a word that he had been taught, but only to demonstrate to a hearing person that he knew it, not for real communication.

The gestures that occurred were almost entirely natural ones adapted to the immediate situation. If a child wanted something he usually expressed himself by pointing to himself and to the object that he wanted. If the object was not present he could sometimes represent it by means of descriptive gestures and he could sometimes describe a simple event by means of pantomime. In addition there were two or three stereotyped gestures that were not so definitely descriptive, for example a wave of the hand that meant *home*. This gesture seems to have been learned from the older children in the school group.

The observer selected three types of communication which were easily distinguished from the general play activity of the children and studied them to determine the relative importance of gesture and vocalization in each. These may be designated as (a) *inquiry* and *question,* (b) *desire* or *wish,* (c) *explanation.* An example of *inquiry* or *question* is a case in which one of the children in the experimental situation was looking for the missing salamanders and held out his hands in a gesture that plainly meant " Where." In *desire* or *wish* the gesture would often take the form of a movement toward the desired object. For example, a child who wished to pass the crackers at lunch motioned toward them and made a movement describing the act of passing, all the time watching the teacher to see whether he would be permitted

to do what he wanted to do. In cases of *explanation* the gestures were usually descriptive, the child pantomiming to show how he had cut his finger, lost a tooth, or played with the salamanders in the other room. In all these cases of communication the gesture was the essential means of transmitting the idea, while any vocalization that occurred was incidental to the actual meaning.

Table IX shows the number of situations in our records in which gestures alone and gesture with vocalization were used in these three kinds of communication. We see that in using *question* or *inquiry* the children made more gestures without than with vocalization. In situations of *desire* or *wish* they used gesture and vocalization more frequently than gesture alone.

TABLE IX

THE OCCURRENCE OF GESTURE AND VOCALIZATION IN SITUATIONS OF COMMUNICATION

	Gesture Alone		Gesture and Vocalization	
	Occurrences	Per cent	Occurrences	Per cent
Question and Inquiry....	19	63	11	37
Desire or Wish.....	47	35	89	65
Explanation.....	60	49	62	57

The urgency behind a *desire* is doubtless greater than that accompanying a simple question, a fact which may account for the greater amount of vocalization on the part of the children of both classes in making communications of that kind. *Explanation* showed a greater amount of vocalization than *question,* but less than communications of *desire* or *wish.* It was probably the most difficult of the three for deaf children, since it often involved objects or aspects of the situation that could not be pointed out and which therefore had to be represented by descriptive gestures. In these cases the difficulty of expression itself may have caused a general increase in tension which brought about greater vocal activity.

E. The use in spontaneous vocalization of speech sounds learned in school

The children of the two classes observed had not begun to carry over to their spontaneous vocalizations the sounds which

they had been taught in school when the observations were completed. The first sounds taught are consonants such as *hw* and *f*, and it is notable that *hw* never occurred in the vocalizations of the children, and *f* represented but .52% of all the consonants.

The one child in the group who had had slight previous training made more consonant sounds than many of the other children. This may or may not have been due to previous instruction.

VI. Summary

Observations were made of fourteen young deaf children, ranging in age from four through seven years, to determine the nature and frequency of the sounds and combinations of sounds occurring in their spontaneous vocalizations, factors influencing the nature of these vocalizations, and their function. All but one of the children were in school for the first time; one had been in school for one year previously.

Records were made of the children in situations of free play and also in an experimental situation. The analysis of the data collected showed:

1. With the exception of five consonants, the range of vowels, diphthongs, and consonants recorded for the group of deaf children included all those of standard English speech.

2. The indefinite vowel *ə* was by far the most frequent. The vowels formed in a middle position, ɑ, ʌ, and æ, were also used frequently while the extreme front and back vowels, *i* and *u*, were among the least frequently used.

3. Among the consonants labials were most frequent, *b* and *m* heading the list. Voiced consonants were more numerous than unvoiced consonants formed in the same position; for example, *b* occurred more often than *p*. The frequency of the nasal consonants *m* and *n*, was less than that of the voiced non-nasal consonants of the same positions, *b* and *d*, but greater than that of the breath consonants *p* and *t*.

4. Twelve different vowels and four diphthongs occurred a

total number of 1578 times as single sounds. Only six different consonants were used singly, in 31 different instances.

5. The deaf children showed a great preference for the use of the consonant in the initial, or releasing, position in the syllable. Twenty different consonants were used a total of 1308 times in this capacity, and only ten in 99 different cases to arrest a vowel.

6. Syllable repetitions, *a–ba, a–ma,* etc., such as occur in the babbling of hearing children, were frequently noted in the vocalizations of the deaf.

7. The frequency of vowels, diphthongs, and consonants used was about the same in the vocalizations of the profoundly deaf and of those having some hearing. There seems to be a tendency, however, for the profoundly deaf children to prefer consonants that are easily produced.

8. Differences in degree of hearing loss did not seem to affect the range of vowels and diphthongs used, but further investigation would be necessary to determine whether the children with more hearing have a greater range of consonants at their command.

9. Degree of hearing did not affect the variety of sound combinations.

10. Individual differences in the kind and amount of vocalizations were not explainable in terms of degree of hearing loss. Other factors such as social maturity, personality, and intelligence were probably important.

11. The children observed during the first months of instruction had not begun to carry over into their spontaneous vocalizations the sounds that they had been taught in school.

12. In the children observed gesture occurred as part of every communication with or without vocalization. Vocalization never occurred alone. In situations of simple inquiry gesture was more frequently used alone than accompanied by vocalization; in situations of desire, wish, or explanation in which there was greater excitement or tension gesture occurred more frequently accompanied by vocalization than alone.

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VI. AN EXPERIMENTAL INVESTIGATION OF LIP-READING

I. Introduction

In a school for the deaf, lip-reading is more important than any single subject in a school for normal children, since it is one of the principal means by which the child makes contacts with other people and obtains information about the world. The problems involved in teaching lip-reading may be considered from two different points of view; first from that of the objective nature of the task itself, second from that of individual differences in ability to master it. The objective difficulties are considerable. The visual aspects of speech, under the most favorable conditions, give an incomplete and often ambiguous representation of speech as we hear it. Many sounds involve movements made in the back of the mouth which are not seen at all under ordinary circumstances. There are a number of cases in which elements that show gross differences in sound are practically identical in their visual appearance. To give two common examples, the words *cart* and *yarn,* or the words *green* and *red,* are pairs which are almost indistinguishable for lip-reading. This means that lip-reading involves the use of different and far less adequate data than those available for understanding speech by hearing.

Further, sight differs from hearing, as a channel for understanding speech, in that it is necessary to look constantly at the face of the speaker while everything else is excluded from close attention. If the lip-reader's attention is not focussed on the speaker, he misses entirely what is said. But we can hear a conversation and at the same time be aware of any number of other auditory phenomena, even those that we would much rather avoid.

This external comparison shows something of the extent to which the data of visually perceived speech and the process of obtaining these data differ from those of heard speech. The

educational problem is further complicated by the marked individual differences that are found in ability to learn lip-reading, differences which often seem quite out of proportion to the pupil's ability to master other subjects. Every teacher of lip-reading, whether he deals with adults who have lost their hearing or with children whose whole education must involve lip-reading, is aware of these differences and recognizes them as one of his greatest problems.

Lip-reading has long been used in the education of the deaf, and teachers of lip-reading such as Nitchie, Müller-Walle, Brauckmann, and Bruhn have brought significant advances in handling the subject and real insight into its nature and the problems that it involves. Study of lip-reading by means of laboratory experiment and controlled tests began much later and so far has not been extensive. Pintner (**18**), using the test method, found a zero correlation between results of lip-reading tests and the Pintner Non-Language Test as given to the advanced classes in a number of schools. He did not believe, however, that he had proved that no correlation exists between lip-reading and intelligence, only that in order to determine it a finer test of lip-reading ability would be necessary.

Other experimenters have made attempts to explain the individual differences in lip-reading ability in terms of personality factors, an approach which is supported by the observations of teachers of lip-reading. Thus Nitchie (**17**, p. 19) says, "The chief difficulties (in the way of the mind) in lip-reading may be indicated by describing the type of mind which is uniformly most successful, and that is a mind which is quick to respond to impressions, or quick in its reaction time, and a mind in which synthetic qualities are dominant."

Similarly Miss Bruhn says, "The student who becomes easily confused because he doesn't 'see' every movement will require a much longer time to master the art than one who, as we say, 'can put two and two together' and let his *mind* supply what his *eye* has missed" (**5**, p. 4).

Among the studies of this aspect of the problem is that of Kitson (**12**), who made tachistoscopic experiments to determine

the relation of synthetic and analytic types of perception to lip-reading ability. He described the analytic reader who grasps the material bit by bit and then puts it together, and the synthetic reader who organizes the material at once into meaningful wholes without paying special attention to details. He believed that synthetic ability in this sense was important for lip-reading. He used a reading experiment and a completion test that were known to be indicative of synthetic ability and compared the results with those of a lip-reading test. He obtained correlations between .60 and .70 with a group of 15 subjects.

Göpfert (10) describes similar experiments in his extensive studies of lip-reading. He concludes that for lip-reading the synthetic type of attention should predominate. At the same time there must be something of the analytic, fixating type which grasps details. He also made experiments to determine the efficiency of different factors involved in lip-reading such as familiarity of content, meaning context, and length of words.

Goldmann (9), who continued Göpfert's work, studied differences in lip-reading which are dependent on differences in language and general mental development. He found that the more highly developed the understanding of language and abstract thinking, the better the lip-reading ability.

In this paper are reported four further studies of lip-reading made to help measure and define some of the problems involved:

I. Tests of lip-reading. Results from three motion picture tests given over a period of five years to groups of deaf children to measure differences in lip-reading achievement show the relation of lip-reading achievement to factors such as age and years of training. A comparison of results from the three tests shows the consistency of rankings within a group after intervals of time.

II. An analysis of the relation between achievement in lip-reading and in other school subjects.

III. The relation of lip-reading of general material to lip-reading of single elements. The experimental work on this subject was followed by a teaching experiment the results of which are included in this paper.

IV. Rhythm and lip-reading ability.

II. The Lip-Reading Tests

A. Description of tests

Three different lip-reading tests were used. Test II was developed from the experience gained in giving Test I, and was presented 4 years after Test I. Test III is an improvement over Test II and was given one year after Test II. Most of the results reported in this paper refer to Test III; for the sake of comparison results of Tests I and II are sometimes considered also.

Test I. The first test consisted partly of related, partly of unrelated words or sentences. Following are the main parts into which it was divided: (1) 15 unrelated nouns, (2) 15 meaningless phonetic combinations, (3) 15 names of animals, (4) 15 unrelated sentences, (5) 10 sentences about simple action pictures. The pictures were shown to the children before the presentation of these sentences.

Examples of the material which were used in the test follow: (1) a ball, a foot, a party, the sun; (2) awth, fou, sof, marp; (3) a cow, a fish, a duck, a fly; (4) A girl has a doll; I like that; A large dog carried a basket; (5) The sun shines; A boy has a pail; The children have no shoes and stockings.

Test II. The second test consisted of 30 names of animals, 30 unrelated nouns, 30 unrelated sentences, and two stories of about 150 words each. The nonsense syllables were left out, since rather few of them were reproduced exactly and it proved too difficult to score the errors. Instead of the sentences about pictures we introduced two stories. Each story was given twice, and then the children had to reproduce it in writing.

The sentences about pictures in the first test and the stories in Tests II and III, were included in order to test the lip-reading of larger connected wholes. Nitchie, in criticizing Conklin's lip-reading test, says (16): "Success in lip-reading is dependent upon far more than the ability to see certain sounds or words or short sentences." And: "One of the most effective lip-reading tests to determine the pupils' skill is from story work." It was surprising to find that lip-reading of stories correlated so highly with lip-reading of unconnected sentences (see later). Nitchie's statement that Conklin's tests "are tests purely for the capacity of the eyes," seems to be exaggerated. Conklin's test included 20 sentences, and the lip-reading of sentences certainly demands alertness and synthetic ability, whose importance Nitchie emphasizes.

Test III. The third test included the same materials as Test II, except that the names of animals were omitted and the stories given in a different way. In the second test the presentation of the stories had the disadvantage that the children had to remember the whole story and the test involved, therefore, not only lip-reading but also memory. This was avoided in the third test by the following procedure: each story was shown first as a whole and then sentence by sentence. At the second presentation the children wrote each sentence after it was given.

The language material used in the tests was always selected in such a way that vocabulary and grammatical structure was well within the grasp of the youngest children tested.

The tests were given by means of motion pictures [1] for which Miss Morris, the teacher of lip-reading at the Clarke School, was the speaker.

The choice of the speaker was made for certain practical reasons. It had the disadvantage that the speaker was more familiar to the older children than to the younger ones. Familiarity with the speaker is certainly important for good lip-reading performance, especially when the speaker has peculiarities of speech. In our case, however, the speaker had very "normal" speech free from peculiarities, and we think that the factor of familiarity had rather little influence. In cases where the possibility of this influence was important for our results, we shall present the data for the two groups separately.

Preceding each section of the test the children were told what type of material (nouns or sentences, etc.) would follow. When the stories were given they were told not only that a story would be given but also the name of the story ("Spot," and "Rover"). To avoid fatigue each test was given in two sittings. The children were tested by classes in groups ranging in size from four to nine. A 16-mm. Bell and Howell projector (Filmo Type S) was used. The distance from the projector to the screen was 15 feet. The image of the face was about one foot in length. The children sat 9 to 12 feet from the screen. All of the children seemed to take the test as a pleasant interruption in their regular program. They wrote on boards which they held in their laps.

[1] As to the use of motion pictures in the instruction and testing of lip-reading, *cf.* P. Janowski (**11**), where one can also find literature about earlier attempts; also Mason (**13**).

The words and sentences were given one at a time while the room was dark, then the lights were turned on so that the children could see to write. Indirect lighting of rather low intensity was used; otherwise the repeated changes of illumination would have been a strain for the eyes.

No part of the test except the stories was ever repeated. If a child failed to understand one item he was told that it did not matter, that he should make a dash on his paper and wait for the next. This attitude on the part of the experimenters seemed to keep the children from feeling discouraged when they missed a word, yet all except a few for whom the test was obviously too difficult, seemed to pay close attention and make every effort to understand what was spoken.

The scoring [2] was done on the basis of the number of items reproduced correctly. In the parts containing related or unrelated nouns, one point was given for each correct word; in the parts containing sentences, one point was given for each sentence that was correct and one-half a point when two words were correct. The stories of Test II were scored according to number of correct ideas. For instance, the sentence "There was snow and he was very happy," was divided into two ideas, "snow" and "happy." The stories of Test III were scored like the sentences, since they were given sentence by sentence.

So far as possible the words which belong to homophenous groups (words which look alike on the lips) were excluded from our material. We did not make allowances for substitutions of this sort.

Test	I	was given	to	86	children,	ages	7–17 (Lower and Middle School)
Test	II	"	"	" 93	"	"	9–19 (Middle and Upper School)
Test	III	"	"	" 68	"	"	9–19 (Middle and Upper School)

The three groups did not consist of the same children, although some children took part in all three tests.

Table I shows the intercorrelations between the parts of Test III. The odd-even correlation for Test III is .94±.099, the reliability of the whole test .97±.005.

[2] *Cf.* Mason (14).

B. Consistency of rank in lip-reading

Forty-two children who were tested with Test I were also given, after an interval of 5 years, Test III. The correlation between the two performances is .72±.05. The correlation between Test II and Test III with one-year-interval for 43 children, is .82±.03. These correlations are surprisingly high. We can conclude from them that the lip-reading ability of the children does not change very much through the years in so far as the rank within the group is concerned. The children who had the highest ranks in the first test were still the best ones after five years, and the same is true of the other ranks.

TABLE I

INTERCORRELATIONS BETWEEN PARTS OF TEST III

	Sentences	1. Story	2. Story	Whole Test
Nouns	.78±.03	.77±.03	.78±.03	.88±.02
Sentences		.85±.02	.85±.02	.94±.01
1. Story			.87±.02	.95±.01
2. Story				.93±.01

C. Individual differences and yearly progress

Table II shows the number of subjects tested, range, first and third quartile, maximum possible score, and average yearly progress in score points. The yearly progress (or average difference between two consecutive age groups) is computed by taking the averages of the age groups and smoothing out the resulting curve. The youngest and oldest groups were not considered in this computation. The youngest group in any department consists usually of exceptionally bright pupils and very good lip-readers, while with the oldest ones the reverse is true.

TABLE II

DATA CONCERNING THE LIP-READING TESTS

Test	No. of Subjects	Range	Q_1	Q_3	Maximum Score	Yearly Progress
I	86	13–43	22	30	55	2
II	93	32–134	65	109	162	4
III	68	11–93	43	71	102	3

Inclusion of the youngest and oldest groups would, therefore, unduly influence the results.

It will be seen that the yearly progress is very small in comparison with the range. The correlation between chronological age and lip-reading is .19±.08 for Test III. This means that individual differences are much more important for lip-reading than differences in age. To give an example: the youngest child of the group tested with the first test, an eight-year-old child, was a very gifted lip-reader. Of the 83 children who were tested, her rank was sixth. Only five of all the children, who ranged in age from eight to seventeen years, accomplished as much on the test as this young child. This, of course, is only a confirmation of what every teacher of lip-reading says about differences in ability to learn lip-reading.

TABLE III

AGE AND AVERAGE YEARS OF SCHOOL FOR CHILDREN TESTED WITH TEST I

No. of Children	Age	Average Years of School
10	9	2.45
8	10	2.87
11	11	4.68
11	12	5.00
19	13	6.47
13	14	6.23

D. Influence of training in lip-reading

Since the children began their formal training in lip-reading at different ages,[3] one must ask whether these individual differences result from differences in amount of training. Against such an assumption speaks the fact that there is relatively little progress with age. For even though the children begin school at somewhat different ages, the older children have naturally had on the average more training than the younger ones. Table III shows the average length of training by age groups for the children to whom Test I was given. The first and last age groups

[3] For instance, within the group tested with Test I were children who had begun school at three or four years of age, and others who had not begun until eight or nine.

in which the number of children was too small for the computation of an average were left out.

The evaluation of the training was difficult because many of the children had entered Clarke School from other schools and it was sometimes impossible to know what kind of work they had had. We decided on the following plan: Each year's work at Clarke School or any recognized school for the deaf was counted as a full year. Each year in a school for hearing children was given half credit, if the child had stayed more than one year. If he had stayed only one year, or less, it was assumed that he had been unable to gain anything from the school, and the time was not counted. Similarly, half credit was given for part-time tutoring.

It is clear from the table that on the whole there is a correspondence between age and length of training. If training has a great influence on lip-reading, then the older children as a group should surpass the younger children much more than they do.

TABLE IV

AVERAGE LIP-READING SCORE AND YEARS OF TRAINING FOR GOOD AND POOR LIP-READERS SEPARATELY, TEST I

	No.	Av. Lip-Reading Score	Av. Years of Training
Good Lip-Readers	29	30.8	4.77
Poor Lip-Readers	28	22.8	4.95

Nevertheless it is possible that within these age groups the children who were better lip-readers were those who had had the most training. The following comparison was made to see whether this was the case. The children were grouped according to age by years, and each age group was divided into halves according to the lip-reading scores, *i.e.*, as nearly as the distribution of the scores would allow. Then the average amount of training for all of the better and all of the poorer lip-readers so selected was calculated.

In each department there is a group of children who are older than the other children and who have had more training because their general school progress has been slower. By treating the age groups in this way the influence of this process of selection was excluded. A single correlation coefficient between training and lip-reading would not give a fair picture of the relationship between the two, since there is this selected group of poor lip-readers with long training. It would only be possible to make such a correlation if the groups were equated for intelligence, but this cannot be done with the methods now available for measuring the intelligence of deaf children.

Table IV shows the results of this comparison for Test I. We see that on the average the poorer lip-readers have had as much

training as the better ones. The difference of 0.18 years in favor of the poorer lip-readers is not statistically significant.

The differences in lip-reading between the groups in Table IV cannot be attributed to differences in the age at which the children became deaf. In each group selected on the basis of lip-reading scores were 22 children who had become deaf before they were one year old, four or five who had become deaf between the ages of one and three and one-half, and only one in each group who had become deaf later (at 4 in one case, at 6 in the other). Age of onset of deafness certainly has influence on lip-reading performance (*cf.* Göpfert, **10**, and Goldmann, **9**), but it cannot explain the difference between good and poor lip-readers in this case.

In any case it is difficult to determine the relation between the age of onset of deafness and proficiency in lip-reading in a statistical way. Each case has to be considered individually. Two factors have to be taken into account: on the one hand the child who becomes deaf at, for instance, 8 years of age has an advantage because he has a greater mastery of language; on the other hand he is often at a disadvantage because he does not get the careful drill in phonetics which young deaf children usually receive and which, as we shall see later, seems to be one factor in good lip-reading performance.

These results seem to show that after a certain amount of training there is hardly any improvement in lip-reading as such. Obviously, if we had included in our test children who had had still less training, we would have found an enormous improvement due to the initial training. The youngest children that we tested had already been in school for one and a half years. Unfortunately we could not obtain lip-reading scores for children with less training, since ignorance of language made it impossible to find material on which to base a test.

We have to emphasize again that we would have found far greater differences due to length of training if we had used more complicated language forms as test material. But this would indicate chiefly a difference in knowledge of language, which could also be acquired by reading, without any knowledge of lip-reading.

III. Lip-Reading and the Results of the Stanford Achievement Test

The correlation between Lip-Reading Test III and educational age as determined by the Stanford Achievement Test is .54±.06[4];

[4] This is in close agreement with Pintner (**18**), who found an average correlation of .49 between lip-reading and the Pintner Educational Survey Test.

between Lip-Reading Test III and the language score of the Stanford Achievement Test, .64±.05. The importance of knowledge of language for lip-reading is obvious and these correlations are what we would expect.

IV. The Rôle of Elements in Lip-Reading

In addition to these general lip-reading tests, two tests were given which involve only the lip-reading of vowels or only that of consonants.

The vowel test contained 16 syllables like parp, pip, poop, etc.; that is, 16 vowels enclosed by *p*, and further, 16 syllables in which the same vowels were presented with *f* instead of *p*. The consonants *f* and *p* were used because they are clear on the lips. The vowels used were: oo, o–e, aw, –o–, ee, í, a–e, –e–, –a–, ar, –u–, ur, i–e, ou, oi, u–e.[5] As an introduction three combinations with *t* (tet, tate, toit) were given for practice and it was explained that the consonant would be the same throughout the series, while the vowels would change. Before each series they were told which consonant would be used. The test was scored by giving 1 point for each correct vowel.

An analogous test was given for consonants. It consisted of 40 nonsense syllables: the first 20 made of the consonants m, p, b, n, t, d, g, k, th, s, sh, ch, j, wh, l, f, v, r, h, y, with oi (moi, poi, . . .), the last 20 of the same consonants with –i–. The syllables of each series were presented in mixed order so that similar sounds did not come together. In scoring the test, allowance was made for homophenous sounds. The following list shows what substitutions were accepted as correct: p and b for each other; d and t for each other; sh, ch, j for each other; e and ee for y.

The vowel test was given to 81 children of the Middle and Upper Schools (ages 9–19), the consonant test was given to 39 children of the Upper School (ages 14–19). The tests were presented by one teacher in the Upper School and one teacher in

[5] In this paper the phonetic spelling according to the Clarke School Charts is used (**23**). Expressed in symbols of the international phonetic alphabet these vowels are: u, ou, ɔ, o, i, I, e, ɛ, æ, *a*, ʌ, ə, ai, au, ɔɪ, ɪu.

the Middle School. The teachers were familiar to the children. Although consonant and vowel tests were constructed on the same principles, the results showed that there are great differences between them. The correlation between the two parts of the vowel test is .73±.03, of the consonant test, .43±.09. Lip-reading test III shows a correlation of 68±.09 with the vowel test, a correlation of 23±.08 with the consonant test. In other words, the consonant test shows less reliability and correlates less with general lip-reading ability.

A closer analysis of the results of the tests shows the reason for this difference between vowel and consonant test. For this comparison of vowels and consonants only the results for the Upper School are taken into consideration, since the consonant test was given only to the Upper School. In this analysis no allowance was made for the substitution of homophenous sounds.

First of all, the range of scores on the vowel test (5–32) is much greater than that of the consonant test (20–36), and that in spite of the fact that the maximum possible vowel score (32) is smaller than the maximum possible consonant score (40). This difference in the range is caused by the different character of the relationships between the different vowels on the one hand and between the different consonants on the other hand.

Tables V and VI show these relationships as far as they can be determined in such a limited test. One can see, for instance, that the vowel *oo* was recognized 67 times as *oo,* that is, correctly; once as o–e; once as *aw*; and so on. Since each vowel was given twice in the test, once in the combination with *p* and once with *f,* and the number of subjects was 37, there were 74 readings for each vowel. For the consonants the number of subjects was 39, the number of readings therefore 78.

These tables show that the misreadings with consonants are much more clustered in groups, while with vowels they are more evenly distributed. Typical, for instance, is the group of labials: *m, p,* and *b.* Even for the best lip-reader it is almost impossible to distinguish between them, while on the other hand even the worst ones do not mistake them for a consonant outside this group. Among the vowels we do not find such groups. The

TABLE V

Mistakes in the Lip-Reading of Consonants

Column at the left consonants as they were given; line across the top consonants as they were understood by the lip-readers.

	m	p	b	l	n	t	d	g	k	y	h	s	sh	ch	j	wh	f	v	r	th
m	*40*	14	23																	
p	18	*25*	35																	
b	21	34	*21*		1															
l				*70*	5			1												
n			1	18	*32*	12	7	1	2											
t					16	*36*	16	3	3		1	1								
d			1	14	22	*28*	4	3												
g					1	2	*22*	29	2	1	3			1						
k					3	3	11	*52*	4	3										
y				3	7	5	10	9	*12*		6		1	1						
h							3	11		*41*				1						
s						1					*54*									
sh							4			1		*25*	18	14					1	
ch										1	14	42	*12*	9						
j								1	1		4	18	23	*24*						
wh																*4*			3	
f																	*68*	10		
v					2	1			4			1					18	*48*		
r									2				1				1		*70*	
th													1							*74*

TABLE VI

Mistakes in the Lip-Reading of Vowels

Column at the left vowels as they were given; line across the top vowels as they were understood by the lip-readers.

	oo	o–e	aw	–o–	ee	–i–	a–e	–e–	–a–	ar	–u–	ur	i–e	ou	oi	u–e
oo	*67*	1	1								*2*				*2*	
o–e	4	*52*		5									1	3		1
aw		1	*60*	7						3		1		1		
–o–		1	6	*37*		*2*	*2*	1	1	6	11					
ee					*57*	4	1	9					1			
–i–				1	14	*46*		8			1				1	1
a–e					1	1	*43*	5	8	1	1		7			
–e–					*2*	17	3	*24*	3	1	7		*7*			
–a–		1	1	3		2	5	4	*20*	9	13		8			
ar			1	9			1		6	*46*	*2*		8			1
–u–		*2*		3	3	13	3	14	5	1	*24*	1				1
ur												*66*				
i–e						*2*	14		1	1			*52*			
ou		8		1			1							*61*		
oi		1		4			1				1			1	*49*	3
u–e	*27*	1									2			1		*47*

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differences are there more finely graded. There are no two vowels which are homophenous in the same way as *p* and *b* are homophenous.

This difference can also be expressed quantitatively. We can arrange the vowels which are substituted for a given vowel in a series according to the number of mistakes. So, for instance, *ar* was read in 9 cases as –o–, in 8 as i–e, in 6 as –a–, in 2 as –u–, in 1 as *aw*, and in 1 as a–e. We obtain so the following order for the mistakes arranged according to their frequency: 9, 8, 6,

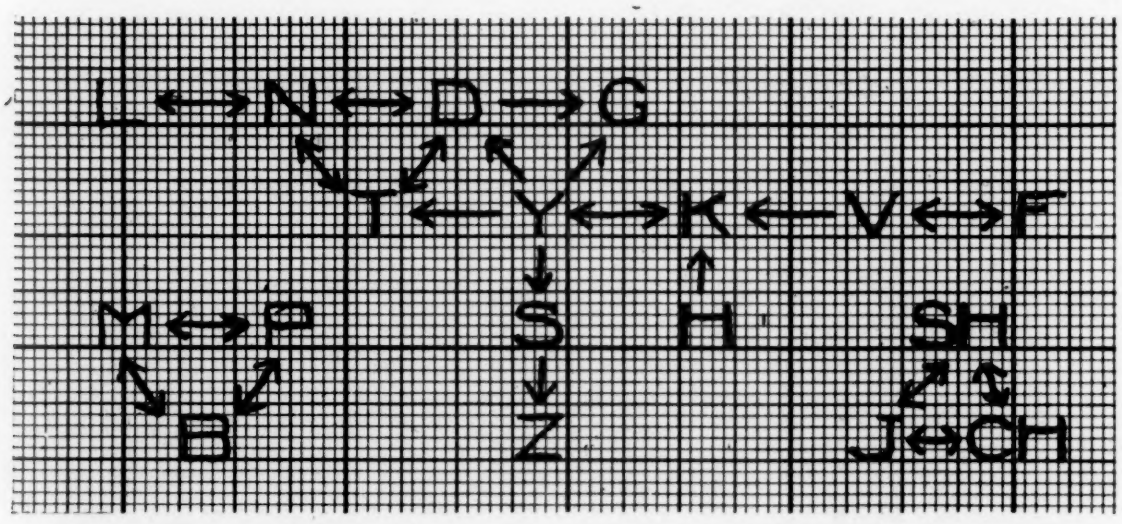

FIG. 1. Chart showing the relationships between consonants in lip-reading. (Arrow from *d* to *g* means: *d* was read as *g* in more than 5% of cases, etc.)

2, 1, 1. If what we said above is true, there should be with consonants much more often an abrupt decrease in such a series than with vowels. The series for *ar*, for instance, goes down gradually, the greatest jump occurring between 6 and 2; that is, with a difference of only 4. For the consonant *b* the series is: 34, 21, 1; the series drops suddenly with a difference as great as 20 between two consecutive numbers. The average of the maximum differences for vowels is 6.4, for consonants 13.5. With vowels, 13 of the maximum differences are below 10, 3 above 10; with consonants, 7 below 10, 13 above 10. That confirms what has been said above.

The results of this experiment allow us to chart the relationships between vowels and between consonants for lip-reading as shown in Figures 1 and 2. The arrows have the following mean-

ing: the element from which the arrow starts was read in more than 5% of all readings of this element as the element to which the arrow points. *L* was read as *n*, and *n* as *l* in more than 5%

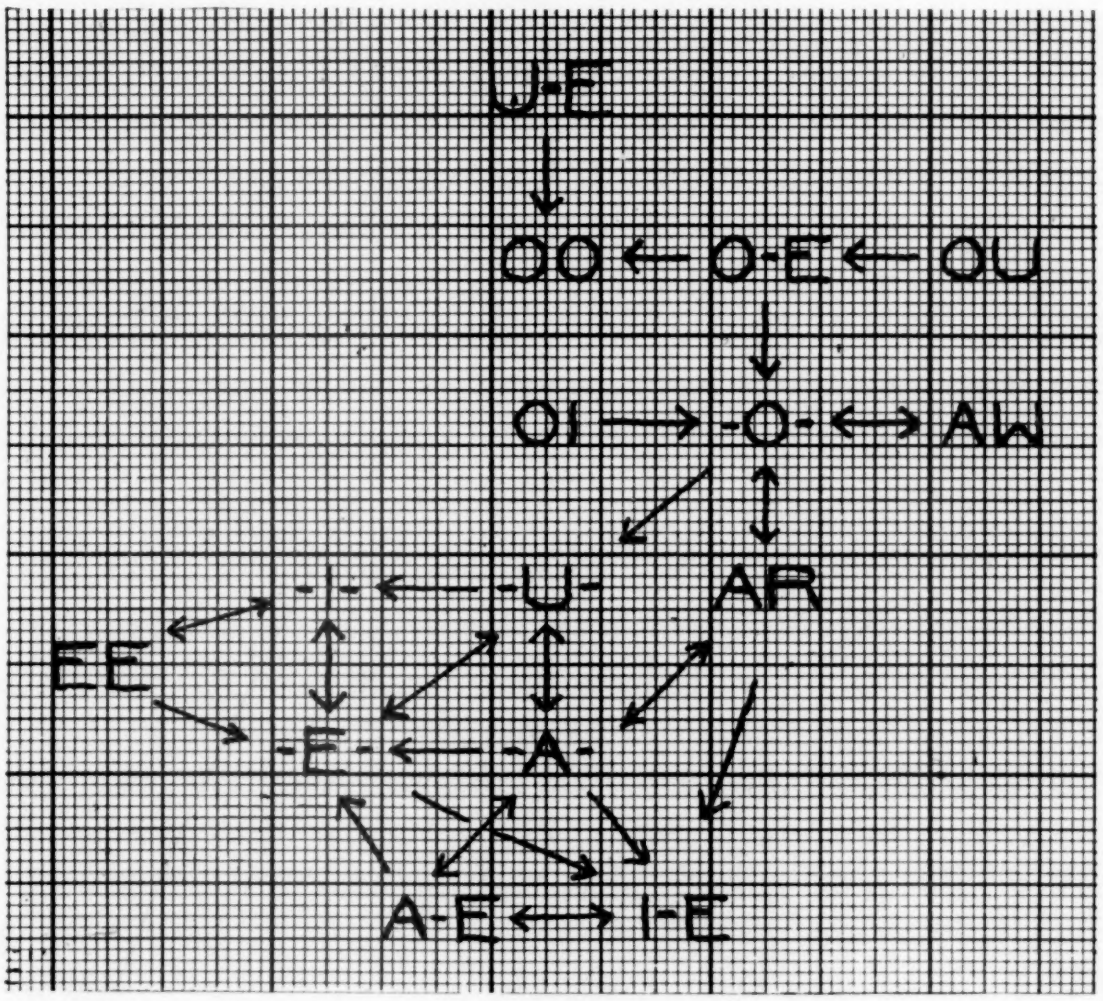

FIG. 2. Chart showing the relationships between vowels in lip-reading. (Arrow from *u–e* to *oo* means: *u–e* was read as oo in more than 5% of cases.)

of the cases. *D* was read as *g* in more than 5% of the cases, but not *g* as *d*, and so on.

These figures show again the difference between vowels and consonants. The net of relationships between the vowels is more complicated; there are more centers like –a– and –o– with similarities in different directions. With the consonants we find the main groups arranged in a much more one-dimensional order. The triangles *m, p, b,* and *sh, ch, j,* and also the unconnected consonants *th, r,* and *wh,* are outside the main group. With the vowels only *ur* is not in the main group.

In Table VII the sounds are compared according to the percentage of correct recognitions; that is, in what per cent of the total number of presentations the sounds were read correctly from the lips. In this comparison, of course, we count an element as correctly recognized only when it is reproduced exactly, and not when it is reproduced as a homophenous sound. The consonants have a greater range of distribution, while most of the vowels are clustered between 50% and 80%.

TABLE VII

PER CENT OF CASES IN WHICH SOUND WAS RECOGNIZED CORRECTLY

Per Cent Correct	Consonants	Vowels
90	l, r, th	oo
80	f	ur, ou, aw
70		ee, o–e, i–e
60	s, k, v	oi, u–e, –i–, ar
50	h, m	a–e, –o–
40	t, n	
30	d, p. sh, j	–e–, –u–
20	b, g	–a–
10	ch, y	

With all these results one has to keep in mind that they were gained with somewhat limited material. It is quite possible, for instance, that the similarities between vowels would change somewhat if one would consider not only the vowels in combination with *p* and *f*, but in combination with all possible consonants. However, such an enlargement of the experiment would probably not fundamentally alter the results as far as the difference between vowels and consonants are concerned.

To summarize once more the findings: the differences between vowels are arranged evenly and continuously; the differences between consonants are arranged unevenly; we find clusters of almost undistinguishable sounds which are separated from others by great differences.

What does this mean for lip-reading? It does not imply anything about the relative importance of vowels or consonants for lip-reading. However, for the learning of lip-reading vowels seem to be much more important than consonants. The difference between good and poor lip-readers shows in the finer or less

fine perception of vowels, while with consonants there are no great differences between them. With consonants one cannot make great progress; that a certain consonant belongs, for instance, to the group of *m, p,* and *b,* one can see without much training—and no amount of training makes it possible to distinguish accurately between these three consonants. On the other hand with vowels, where the differences are much more gradual, one can learn to make finer and finer differentiations. In the beginning one may mistake the vowel –a– for one of the following vowels: –e–, –u–, ar, i–e, a–e. Gradually one excludes the mistakes, and for the good lip-reader it is perfectly possible to recognize –a– as such. The poor lip-reader makes more mistakes with vowels than with consonants, the better lip-reader fewer mistakes. This is the reason for the fact that the correlation between vowel test and lip-reading is righer than between consonant test and lip-reading.

Nevertheless it is surprising that there is such a high correlation at all between lip-reading of meaningless material of such simplicity, and lip-reading of meaningful sentences and stories. One could have assumed that after so many years of training each child would have mastered the lip-reading of these "elements" and that the differences in lip-reading would be caused entirely by differences in the ability to form the correct response to a complex manifold of those elements. However, we find that this is not the case and that even with the older children there are great differences in the accuracy of recognizing vowels in a constant surrounding. It is easy to understand that for the child who has difficulty in recognizing vowels the task of lip-reading is much harder; it means that the combination and interpretation has to be made with the help of fewer cues.

In regard to the teaching of lip-reading, the results of this experiment suggest that training in vowel recognition may increase lip-reading ability. To test this assumption an experimental teaching program was planned and carried out by Miss Mary Numbers, teacher-in-charge of the Middle School of Clarke School. Eight children chosen from among the poorest lip-readers (ages 13–16) were given a twenty-minute period of

training in the recognition of vowels each day for 14 weeks. Groups of sentences were constructed which were alike except for the vowel in one word. For example: Is Mary afraid of the dog? Is Mary afraid of the dark? . . . of the duck? The sentences were written on the slate and the children had to point out which was given in lip-reading. These exercises thus put the emphasis on single vowels, but always presented them as parts of sentences. Tests in lip-reading were given before and after the training period to these eight children and to a control group of eight children who did not have this training. A comparison of the average rank places of the children of the two groups showed a decided gain by the experimental group. While before the training period the average rank places were almost the same for the two groups (experimental group 8.6; control group 8.4), after the training the experimental group was 2.8 rank places better than the control group.

There were marked differences between the children in the way in which they responded to the training. Two gained practically nothing and were definitely bored by the work. The others who made real gains showed great interest and told their teacher that the work was helping them and giving them confidence in their lip-reading. People who did not know about their training commented on the improvement in some of the children.

V. The Rôle of Motor Organization in Lip-Reading

Teachers of lip-reading have often called attention to analogies between lip-reading and the following of a rhythm. Thus Miss Bruhn compares lip-reading to understanding of music. In the Jena method the emphasis on rhythm is still greater. For Brauckmann an understanding of the motor rhythms of speech is fundamental to lip-reading (3, 6).

It seems reasonable that there should be such a relationship. Both lip-reading and the following of a rhythm involve a series of successive events and organization into larger wholes; and in both cases bodily movements play a decisive rôle. The final units which lead in the organization are, however, not the same in the two cases. In lip-reading these final units are the units of lan-

guage and thought, the meaning of the spoken sentences. In following a dance rhythm the final units are units of movements of the body.

The Jena method does not contend that lip-reading is exactly like following a rhythm; what this method implies is only that the organization which has, so to speak, at the one end the visual data and at the other end the final focus in the region of language, should include as a middle step the motor region. This may be a very important point of view. The results of this study which have bearing on this question are very fragmentary and only to be taken as indications.

TABLE VIII

AVERAGE LIP-READING SCORE FOR CHILDREN WITH DIFFERENT GRADES IN RHYTHM PERFORMANCE

		Grade in Rhythm Performance				
		1	2	3	4	5
Test I	Number of children.....	21	38	13	9	
	Average lip-reading score	18.6	15.7	13.5	11.3	
Test II	Number of children.....	2	14	21	14	9
	Average lip-reading score	86	73	58.4	51.4	44.3

A. Lip-reading and following a rhythm in dancing and gymnastics

We are able to compare the results of the Tests I and III with performance in following a rhythm. The teachers of gymnastics and dancing graded the children in the ability to follow rhythms.[6] For the children who took part in Test I four grades were used; for the children who took part in Test II, five grades.

Table VIII gives the average lip-reading score for these groups. Thirty-nine of the children were the same in both tests.

We see from this table that the children who can follow a rhythm better are also better lip-readers. Since there is practically no relation between rhythm performance and intelligence,[7] the

[6] Unfortunately it was not possible to use a standardized test for rhythm, since these tests involve the use of hearing for the most part. Teachers' ratings were the only available data, and since only one teacher worked with each group of children, it was impossible to compare different judgments and determine their reliability. However, the teachers handle the children in small groups and know them well enough so that we can assume that the ratings have some validity.

[7] *Cf.* Alstyne and Osborne (1).

relation between lip-reading and rhythm performance cannot be due to intelligence.

This result, of course, does not show whether further training in rhythm would improve lip-reading, or whether the relation is only between the child's original ability to learn to follow a rhythm and his original ability to learn to read the lips as they have been developed in a given environment.

B. Lip-reading of Sequences of Nonsense Syllables

In this experiment the attempt was made to exclude (1) the influence of familiarity of elements, and (2) the influence of the higher regions of organization into meaningful language. Material can be obtained in this way whose correct recognition ought to depend to a high degree on the organization within the motor region.

Ten sequences of nonsense syllables like: far lar far, or: thar lar thar far, were given in lip-reading. Only the consonants *f, l, th, p,* and the vowel *ar* were used in constructing the syllables. Five sequences contained six syllables; three contained five syllables; one contained four, and one three, syllables. They were given in the same way as the vowel and consonant tests, that is, in class groups and always by the same teacher. In scoring, a correct syllable in the right position was counted as one point.

One should suppose that a person for whom lip-reading is largely an "imitation of the movement pattern" (what it would be according to the Jena School) should be very good in this test. And if for lip-reading in general, movement imitation is so important, one should suppose that there is a high correlation between general lip-reading and performance in this test.

The test was given to 39 children (ages 14–19) twice with an interval of one month. The correlation between the results of the two trials was $.73 \pm .05$. The correlation between this test (average of both trials) and lip-reading Test III is insignificant: .04 ($n=35$).

This result is certainly surprising. Of course, it does not prove that the Jena method is of no value. One could make the following assumption to explain it: it concerns this part of the

whole organization of the lip-reading process which is the result of motor concomitants. This part, as we have seen, should play only a subordinate rôle; it should only lead up to the meaning of the spoken phrases. In this experiment the lip-reader was required to form independent organizations in the motor region. That is a different process and demands different " abilities " on the part of the lip-reader.

However, against that assumption speaks the fact that there is a correlation between lip-reading and following a rhythm. For in following a rhythm one also has to form independent motor organizations.

On the basis of the available data the results of these experiments cannot be explained. Further experiments are needed to clear up the rôle of motor organization in lip-reading.

V. Theoretical Discussion

As every perceptual process, lip-reading can be determined in many different ways. It involves speaker and mediating processes in the environment, and a complicated organization at several levels in the perceiving person. When in the following an attempt is made to describe these different aspects of the whole process, we do not imply that they could in reality be divorced from the whole process and, for instance, measured by partial correlation coefficients. As Stobschinsky (21) points out, the lip-reading performance may be of quite different structure in different persons; and this difference in structure cannot adequately be described merely by attributing it to a distribution in the weight of different factors.

A separation of the different contributing factors, as it is often attempted in an analysis of reading difficulties, must be, at this stage of our knowledge of the process, necessarily superficial. Such a separation requires the indiscriminate use of concepts of performance and of achievement. Some of the " factors " may correspond to parts of the process which have dynamic reality; other factors owe their place in the analysis only to the insufficiencies of our approach; they are artefacts which are produced by the clumsiness of the measuring devices which we apply to

the process. However, if we keep these limitations in mind, it may be fruitful to put together all the facts which have, as far as we can see, influence on the process. In Table IX these facts are listed in the order in which we discuss them.

TABLE IX

FACTORS WHICH INFLUENCE LIP-READING ACHIEVEMENT

I. Factors concerning the speaker:
- A. Distinct lip movements
  1. Character of normal speech of speaker
  2. Intention to speak clearly
  3. Involuntary variations
  4. Familiarity of speaker to observer
- B. Clear visibility
  1. Distance
  2. Light
  3. Position of speaker relative to reader

II. Factors concerning the material:
- A. Vocabulary
  1. Objective frequency
  2. Individual's experience
  3. Abstract or concrete words
- B. Sentence form: simple or complex
- C. Context
  1. Perceptual field
  2. Language field

III. Factors concerning the lip-reader:
- A. Visual factors, eyesight
- B. Ability to recognize elements (especially vowels)
- C. Kinesthetic factors
- D. Language development
- E. Intelligence
- F. Information, familiarity with content
- G. Synthetic ability, quick combination
- H. Attitude of receiving
  1. Social responsiveness in general
  2. Emotional Contact with speaker
  3. Interest in speaker or content
  4. Voluntary attention

The importance of the factors concerning the speaker is obvious. Very little experimental evidence is available in regard to the question how a variation of these factors changes lip-reading achievement. It would be interesting to find out how the legibility of lips of persons who are in steady contact with the deaf compares with that of other persons. Pintner (18) gives data which allow a comparison between tests given by a teacher familiar to the pupils and tests given by an outside examiner.

There is a difference of 11.7 points between the means in favor of the teacher; it is 5.85 times as great as the standard deviation of the difference. However, we can draw no conclusion from such a single experiment. We do not know how much the intention to speak clearly influences lip-reading or whether there are any involuntary variations in the legibility of the speech of the same person. The latter question would be important if we would want to get comparable test results from tests spoken by the same person at different times.

Motion pictures are used in lip-reading tests in order to keep the factors concerning the speaker constant.

In presenting a lip-reading test by means of a motion picture one has to make sure that the speed is kept constant. Furthermore, the projector must run smoothly. Special attention has to be paid to the finger which carries the film. If it does not function properly, it may widen the holes in the film. A film thus spoiled gives jerky projection and is no longer usable as test.

Among the factors concerning the materials we find first the objective frequency of words. Other conditions equal, it is easier to read from the lips material which consists of familiar words than of unfamiliar words. Göpfert (10) mentions a few experiments concerning the rôle of sentence form and context in lip-reading. We may distinguish between the context helps which come from the wider situation and the actions of persons, and the context helps which lie in the language field itself; for instance, in the conversation which has been going on.

We come next to the factors which concern the lip-reader himself. Visual acuity is the most peripheral factor. We might say roughly it is as important for lip-reading as for reading, or perhaps more important. But we do not know whether it is important in the same way; *i.e.,* whether the difference aspects of good eyesight are not of different weight in reading and in lip-reading performance.

The recognition of elements has been treated in this paper. It has been found that consonants and vowels play different rôles.

The importance of the motor region has also been discussed.

The next factor to be considered is language development, familiarity with vocabulary and with language forms, and facility

in the use of those forms which are known. The correlation between educational achievement and lip-reading is probably due partly to this factor. It is difficult to measure this relationship directly in deaf children, since lip-reading probably affects language development as much as readiness in the use of language affects lip-reading. Experiments with deafened adults should give more decisive results, since language forms are already established and the facility with which they can be employed is not affected—at least not in the same way—by ability to read the lips. The same relationship, of course, exists between a person's general information and, more specially, familiarity with a given content and success in lip-reading.

The relationship between general intelligence and lip-reading is another problem which has not yet been handled adequately. Even with hearing children it is theoretically impossible to distinguish between educational achievement and intelligence. Instead of speaking of intelligence and educational achievement we should say: performance in so-called educational achievement tests and in so-called verbal intelligence tests. Some tests, it is true, test more special information, and others more general forms of thought and language, but it is impossible to separate these aspects of mental development entirely. This holds to a still greater degree for deaf children.

We mentioned Pintner's study (18) in which he reports a zero correlation between lip-reading and intelligence. The great difficulty is to find a relatively adequate intelligence test for deaf children. Any test involving the use of language is an achievement test for a deaf child who acquires the use of language only as a special school subject. And the tests so far devised which do not involve language do not give an adequate measure of the kind of abilities that are required to learn language and other school subjects which are presented in language form.[8]

Goldmann (9) reports interesting experiments on the relation between mental development and lip-reading. He made experiments in which he compared the lip-reading of persons who had

[8] *Cf.* Schick (19) for a discussion of the use of mental tests with deaf children.

lost their hearing between the ages 12–17 years after acquiring language, with that of congenitally deaf people. The late-deafened group was worse in the lip-reading of words which were not arranged according to content, but better when the words were grouped according to their meaning. That means, the late-deafened group gained more than the early-deafened by context helps. He found in general that the meaningful organization is more potent with the late-deafened. With these persons there is a strong tendency toward lip-reading a meaningful sentence, which is not always the case with the early-deafened. With the latter the meaning of the sentence which they produce as read from the lips is often disturbed by words which have nothing to do with the rest of the sentence, or they produce a jumble of words without connection.

In experiments in which he let the lip-readers know the verb of the sentence in advance, the tendency to read a meaningful sentence was very much strengthened with both groups. He says that the attitude of being directed towards meaning is most important and that this attitude is strengthened by knowledge of the verb of the sentence.

In another group of experiments he presented sentences which contained common words and phrases which have no concrete meaning, like " so to speak," " on the whole," " generally," etc. These sentences were difficult to read from the lips and words with definite meaning are usually substituted for these words. By another experiment he proves that lip-reading is more difficult when the material contains negation, passive or conjunctive form; that is, more abstract thought and language forms. Goldmann concludes from these experiments, that lip-reading favors concrete organizations of a lower order and that mastery of the more abstract forms and meanings cannot be acquired through lip-reading, whereas the mastery of abstract meanings is a condition for good lip-reading.

The evidence is very strong that factors related to personality are of at least as great importance for lip-reading as mental development. The analyses made by teachers of lip-reading as well as the experimental work of Kitson (12) and Göpfert (10),

indicate that synthetic ability—the ease and speed with which greater wholes are organized—is very important. It seems probable that the more recent psychological studies of personality will be important for the understanding of individual differences in lip-reading. We shall report in a later publication on some experiments in regard to this problem.

In addition to these more specific factors, certain general factors probably influence lip-reading greatly; for instance, ease of establishing rapport, or receptiveness. As we have seen, lip-reading is a very labile function. The mere fact that, from a psychological point of view, one person lives in a larger world or a larger social group than another, can be very important for the general level of his lip-reading performance.

A second factor of this kind may easily be his relation to a particular speaker or a particular situation. Phyllis Blanchard, in a paper on reading difficulties of hearing children (4) showed how negative attitudes toward parents and teachers may color the whole school situation and result in failure in reading as the subject which is most stressed in the first school years. This is probably still more true for lip-reading, into which social factors must enter to a still greater extent since it is a person-to-person communication.

Similarly, interest in a speaker or a particular subject can favor the attitude of receptivity that helps lip-reading.

To put these considerations about the different factors in more general terms: to obtain good lip-reading achievement it is first necessary that the stimulus patterns (boundary conditions) are clearly differentiated. This differentiation must depend on the thought and language forms which the speaker wants to express.

The organization of the lip-reading process proper which resolves these boundary conditions into equilibria, takes place within several regions. The last focus of this organization is the region of language and thought forms, or, since speech is in the end a tool for social behavior, the total response of the person to his social environment.

The most important question for teachers is which of the different factors involved in lip-reading can be influenced in such

a way as to improve the pupils' ability to read the lips and which do not respond to educational methods. It is hardly necessary to mention the importance of routine optical examinations. Utilization of elements is apparently one of the factors which can be improved by special training. Even though it may be relatively external to the whole lip-reading process, it is important, since it represents a point at which special teaching can be made effective. It is interesting to note that in reading, too, this seems to be the case, as recent experiments have shown.

The Jena method has demonstrated that, for some individuals at least, training of the rhythmic aspects of lip-reading has value.

Language development and availability of language forms and of general information, represent other points at which an indirect approach may be made to lip-reading. Attempts have been made to improve the general background by other means (especially reading and motion pictures) in order to bring about mental development which then has influence on lip-reading.

Attitudes such as general receptivity can also be influenced to a great extent. If the teacher realizes that the pupil will actually gain in lip-reading skill if he is interested in the subject, and if he is well adjusted to the whole school situation, she has a definite task in controlling these factors. It is probable that the rhythmical exercises of the Jena method are as important in developing those attitudes of receptiveness as in giving specific training in motor rhythms. At the same time there are some people who definitely resent giving themselves up to influences from the outside, and this may explain the fact that the method is not uniformly successful.

How far such factors as general synthetic ability are susceptible to training we do not know. It may be that this has to do with more fundamental aspects of personality.

VII. Summary

1. Motion picture tests of lip-reading were found to be highly reliable.

2. The rank order of children in lip-reading performances remain constant to a high degree over periods of several years.

3. Great individual differences in lip-reading performance exist between children of the same chronological age.

4. The difference between the average scores of consecutive age groups (yearly progress) in lip-reading is small.

5. The individual differences cannot be due to difference in length of training.

6. A coefficient of correlation of .54 was found between lip-reading and educational achievement.

7. Ability to recognize vowels shows high correlation with lip-reading, much higher than ability to recognize consonants.

8. There is a correlation between ability to follow a rhythm in dancing or gymnastics and lip-reading.

9. There is no correlation between the lip-reading of nonsense syllable sequences and general lip-reading.

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